U.S. AIR FORCE

FINAL
RECORD OF DECISION AMENDMENT

DEEP SOIL, OPERABLE UNIT 2 (OU-2)

CONTRACT NUMBER F41624-94-D-8047, D0007

AIR FORCE BASE CONVERSION AGENCY
WILLIAMS AIR FORCE BASE, AZ 85206

DECEMBER 1996

Table of Contents

Page

List of Tables iv
List of Figures iv
List of Acronyms v

1.0 Declaration 1-1
  1.1 Site Name and Location 1-1
  1.2 Statement of Basis and Purpose 1-1
  1.3 Assessment of the Site 1-2
  1.4 Description of the Selected Remedy 1-2
  1.5 Statutory Determinations 1-3
2.0 Decision Summary 2-1
  2.1 Highlights of Community Participation 2-1
3.0 Scope and Role of Operable Unit 3-1
4.0 Summary of Site Characteristics 4-1
  4.1 Deep Soil at Liquid Fuels Storage Area 4-1
  4.2 Contaminant Fate and Transport 4-2
    4.2.1 Contaminant Persistence in the Environment 4-2
    4.2.2 Organics in ST-12 4-3
5.0 Summary of Potential Site Risk 5-1
  5.1 Chemicals of Potential Concern 5-1
  5.2 Preliminary Remediation Goals 5-2
  5.3 Cleanup Goals 5-3
  5.4 Remedial Action Objectives 5-4
6.0 Description of Alternatives 6-1
  6.1 Alternative ST12-1: No Action 6-2
    6.1.1 Source Treatment Component 6-2
    6.1.2 Source Containment Component 6-2
    6.1.3 Groundwater Component 6-2
    6.1.4 General Components 6-2
    6.1.5 Compliance with ARARs 6-3
  6.2 Alternative ST12-2: Natural Attenuation 6-3
    6.2.1 Source Treatment Component 6-3

Table of Contents (Continued)

Page

6.2.2 Source Containment Component 6-3
6.2.3 Groundwater Component 6-3
6.2.4 General Components 6-4
6.2.5 Compliance with ARARs 6-5
6.3 Alternative ST12-3: Soil Vapor Extraction 6-5
6.3.1 Source Treatment Component 6-5
6.3.2 Source Containment Component 6-6
6.3.3 Groundwater Component 6-6
6.3.4 General Components 6-6
6.3.5 Compliance with ARARs 6-7
6.4 Alternative FT02-5: Bioventing 6-8
6.4.1 Source Treatment Component 6-8
6.4.2 Source Containment Component 6-9
6.4.3 Groundwater Component 6-9
6.4.4 General Components 6-9
6.4.5 Compliance with ARARs 6-10
6.5 Alternative ST12-5: Synergistic Alternative, SVE, Bioventing, and Natural Attenuation 6-10
6.5.1 Source Treatment Component 6-10
6.5.2 Source Containment Component 6-11
6.5.3 Groundwater Component 6-11
6.5.4 General Components 6-11
6.5.5 Compliance with ARARs 6-11
7.0 Comparative Analysis of Alternatives 7-1
7.1 Overall Protection of Human Health and the Environment 7-1
7.2 Compliance with ARARs 7-2
7.3 Long-Term Effectiveness and Permanence 7-2
7.4 Reduction of Toxicity, Mobility, or Volume Through Treatment 7-3
7.5 Short-Term Effectiveness 7-3
7.6 Implementability 7-3
7.7 Cost 7-4
7.8 Support Agency Acceptance 7-4
7.9 Community Acceptance 7-4

Table of Contents (Continued)

Page

8.0 Selected Remedy 8-1
8.1 Major Components of the Selected Remedy 8-1
8.2 Cost 8-4
9.0 Statutory Determinations 9-1
9.1 Protection of Human Health and the Environment 9-1
9.2 Compliance with ARARs 9-2
9.2.1 Chemical-Specific ARARs 9-2
9.2.2 Location-Specific ARARs 9-2
9.2.3 Action-Specific ARARs 9-2
9.3 Cost Effectiveness 9-3
9.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Possible 9-4
9.5 Preference for Treatment as a Principal Element 9-5
10.0 Documentation of Significant Changes 10-1
11.0 Responsiveness Summary 11-1
12.0 References 12-1
Appendix A - Cost
Appendix B - Location-Specific Applicable or Relevant and Appropriate Requirements

List of Tables

Number	Title	Follows Page
5-1	Evaluation of Chemicals of Potential Concern	5-1
5-2	Determination of Chemicals of Concern and Cleanup Levels in Deep Soil Liquid Fuels Storage Area (ST-12), Operable Unit 2	5-3

List of Figures

Number	Title	Follows Page
1-1	Site Location Map	1-1
1-2	Site Map for the Liquid Fuels Storage Area, (ST-12)	1-1
4-1	JP-4 Concentration in 1993 Deep Soil Borings at ST-12	4-1
5-1	Groundwater Contamination Plume at ST-12, August 1995	5-2
5-2	Line of Transport from Source Area to Compliance Point	5-3
5-3	Concentration of Benzene in Groundwater at the Compliance Point Using the Modeled PRG value of 5 mg/kg Benzene in Soil	5-3
5-4	Concentration of Toluene in Groundwater at the Compliance Point Using the Modeled PRG value of 4000 mg/kg Toluene in Soil	5-3
5-5	Concentration of Naphthalene in Groundwater at the Compliance Point Using the Modeled PRG value of 3000 mg/kg Naphthalene in Soil	5-3
6-1	Initial Screening - Deep Soils at ST-12	6-1
6-2	Secondary Screening - Deep Soils at ST-12	6-1
6-3	Remedial Alternative Evaluation Criteria	6-1
6-4	Soil Vapor Extraction (SVE) System Conceptual Flow Diagram Deep Soils at Liquid Fuels Area (ST-12)	6-5
6-5	Bioventing System Conceptual Flow Diagram Deep Soils at Liquid Fuels Area (ST-12) at OU-2	6-8

List of Acronyms

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AFB	Air Force Base
ARAR	applicable or relevant and appropriate requirements
BTEX	benzene, toluene, ethyl benzene, and xylene
Btu	British thermal unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemicals of concern
COPC	chemicals of potential concern
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FS	feasibility study
HBGL	health-based guidance levels
IT	IT Corporation
JP-4	jet petroleum grade 4
LFSA	Liquid Fuels Storage Area
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
OU	Operable Unit
POTW	publicly owned treatment works
PRG	preliminary remediation goals
RA	remedial action
RAO	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RI	remedial investigation
ROD	record of decision
RODA	record of decision amendment
scfm	standard cubic feet per minute

List of Acronyms (Continued)

SHPO	State Historic Preservation Officer
SVE	soil vapor extraction
TOC	total organic compound
TPH	total petroleum hydrocarbons
UCL	upper confidence limit
UST	underground storage tank
USAF	U.S. Air Force
VOC	volatile organic compound

1.0 Declaration

1.1 Site Name and Location

Williams Air Force Base (AFB) is located in Maricopa County, east of the city of Chandler, Arizona (Figure 1-1). Operable Unit (OU)-2 of the Williams AFB National Priority List (NPL) is located at the Base's Liquid Fuels Storage Area (LFSA), which is also referred to as its site designation "ST-12" (Figure 1-2).

1.2 Statement of Basis and Purpose

This record of decision amendment (RODA) prepared by IT Corporation (IT) selects a remedial action (RA) for site cleanup of the deep soil (from a depth of 25 feet to the top of groundwater) at ST-12. Deep soil at ST-12 was originally included in the feasibility study (FS) of remedial alternatives for OU-2 at Williams AFB (Figure 1). As the FS proceeded at OU-2, it became apparent that deep soil at ST-12 required further study. Therefore, it was agreed that deep soil at ST-12 would be removed from OU-2 and grouped with OU-3 sites. This action allowed the FS of the remaining sites in OU-2 to proceed on schedule and provided additional time to study the impact of potential contaminant migration to the groundwater. Extensive testing and modeling conducted as part of the OU-3 FS showed that contaminants in deep soil could travel to groundwater and impact the cleanup remedy selected for groundwater in the OU-2 proposed plan. For this reason, the decision was made to consider all the environmental media at ST-12 as a unit in subsequent studies. Deep soil at ST-12 is, therefore, reincorporated into OU-2.

The results of the deep soil contamination investigation at ST-12 are reported in the OU-3 remedial investigation (RI) report (IT, 1994). The results of the OU-2 investigations are reported in the OU-2 RI report (IT, 1992a). Because this is a RODA, per U.S. Environmental Protection Agency (EPA) guidance (1989), it does not include some of the introductory sections generally found in a record of decision (ROD). This amendment focuses on the changes at ST-12 since the issuance of the OU-2 ROD (IT, 1992b); its primary purpose is to recombine the ST-12 deep soil into OU-2. The selected remedy for shallow soil and groundwater at OU-2 is presented in the OU-2 FS report (IT, 1992c) and ROD (IT, 1992b). This amendment does not change the remedies specified in the OU-2 ROD.

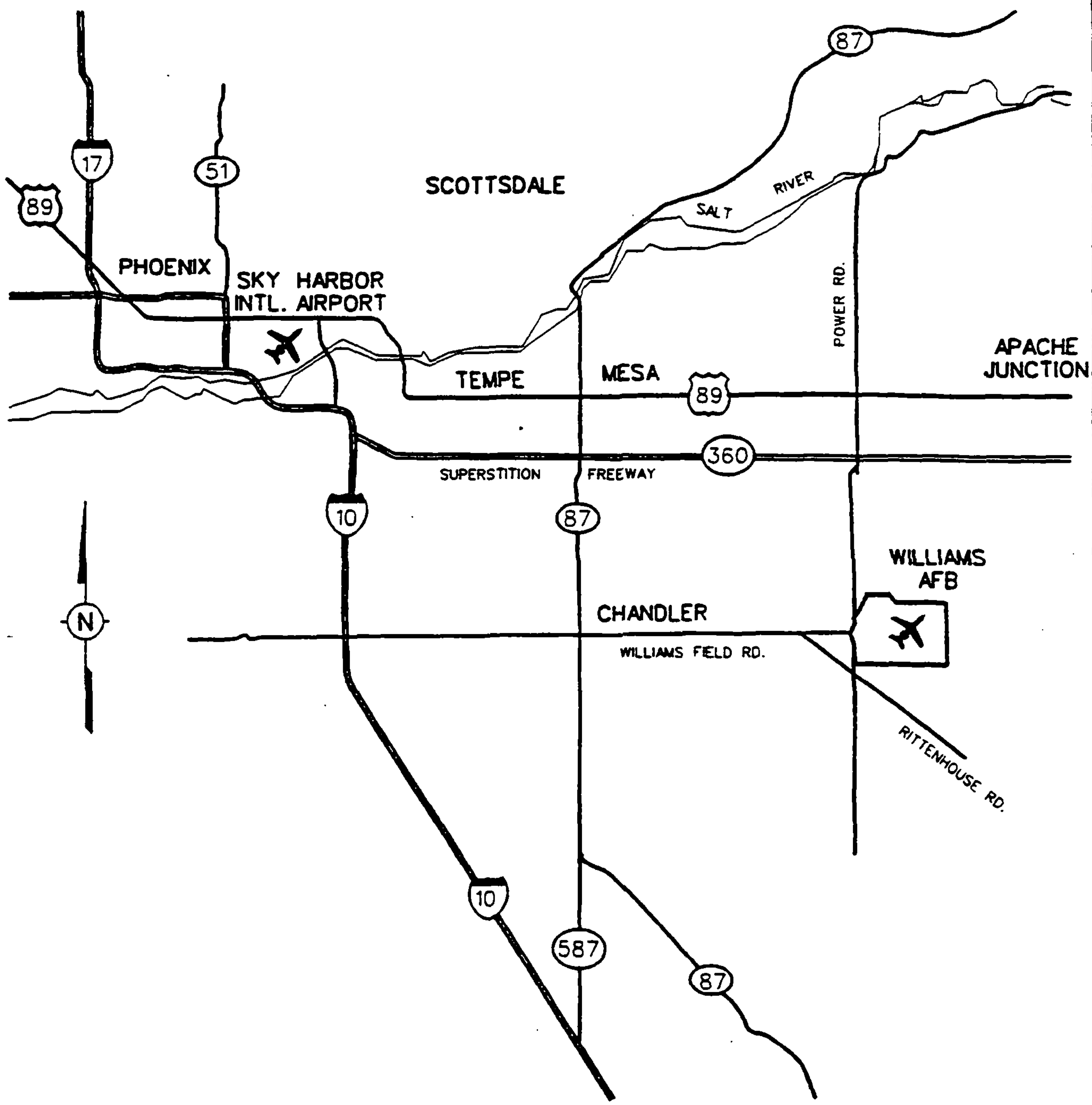


FIGURE 1-1
SITE LOCATION MAP

SCALE

0 5 10 MILES

WILLIAMS AIR FORCE BASE
PHOENIX, ARIZONA

INTERNATIONAL
TECHNOLOGY
CORPORATION

STARTING DATE: 02/24/95	DATE LAST REV.:	DRAFT. CHCK. BY: D.AGUILAR	INITIATOR: D.WILLEN	DWG. NO. 409880ES.003
DRAWN BY: D.HIGGS	DRAWN BY:	ENGR. CHCK. BY: D.WILLEN	PROJ. MGR.: W.CARTER	PROJ. NO.: 409881

FILENAME: G:409880\409880ES.003

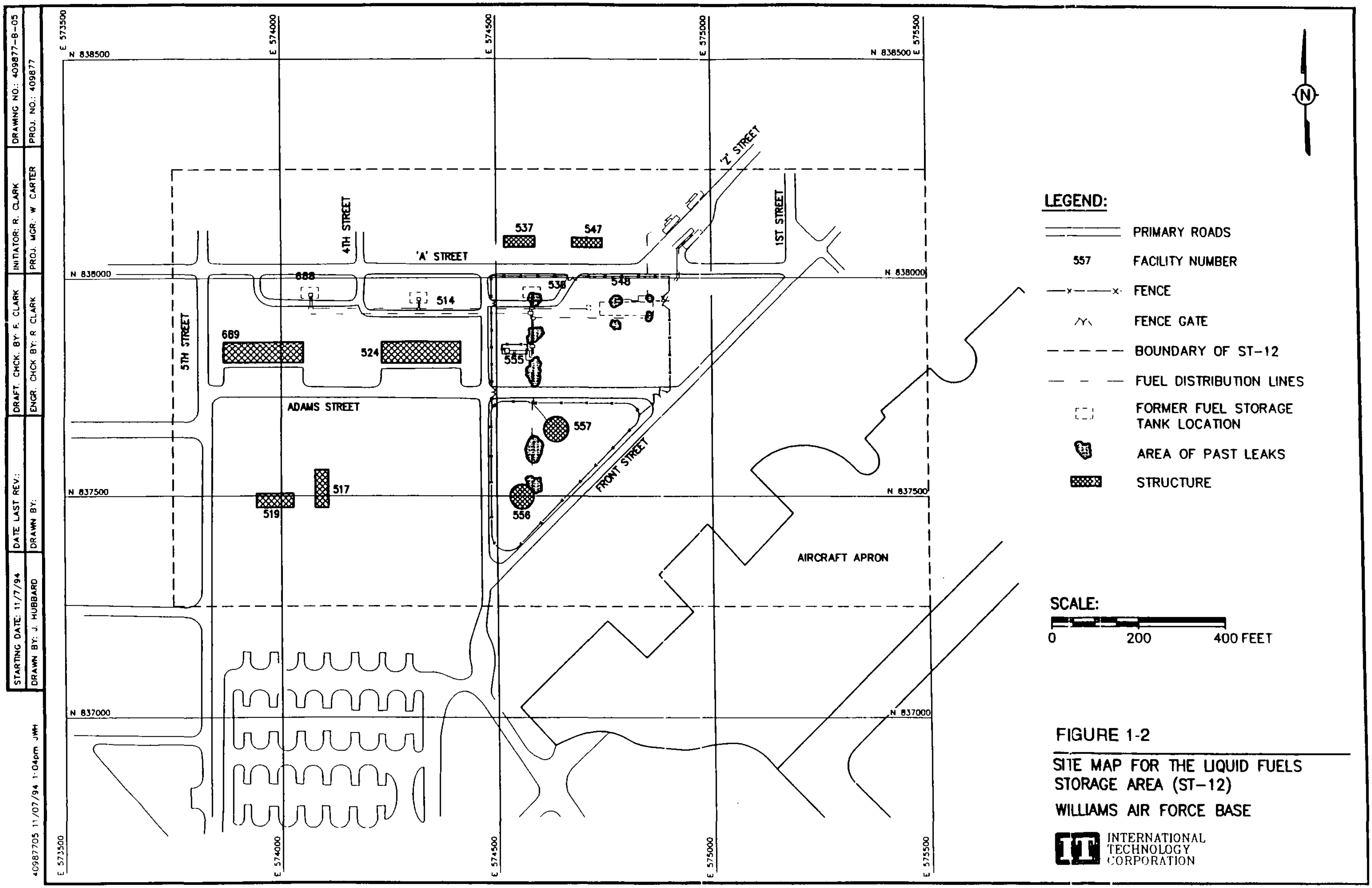


FIGURE 1-2

SITE MAP FOR THE LIQUID FUELS STORAGE AREA (ST-12)

WILLIAMS AIR FORCE BASE

1.3 Assessment of the Site

Releases of jet petroleum grade 4 (JP-4) and aviation gasoline have contaminated soils at OU-2. Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response actions selected in this RODA, may present an imminent and substantial endangerment to public health and the environment. Benzene, which is present in JP-4, is the most prevalent and mobile of the contaminants at OU-2. Where benzene or JP-4 is referred to in this RODA, all of the chemicals of potential concern (COPC) exceeding action levels are also included by reference and will be treated by the selected remedy.

1.4 Description of the Selected Remedy

Environmental remediation at Williams AFB has been organized into five OUs. The U.S. Air Force (USAF), in conjunction with EPA and the State of Arizona, has selected cleanup remedies for OU-1, OU-2, and OU-3. The groundwater and shallow soil at this site are addressed in OU-2. The deep soil at ST-12 will be addressed in this RODA and remedies for the rest of OU-3 are presented in the OU-3 ROD. Investigations at OU-4 and removal actions at OU-5 have been completed and reports are being prepared to document the activities at these sites.

Data gathered from investigations of the deep soil at ST-12 indicated that concentrations of contaminants in the soil warrant further action. The selected remedy is a synergistic combination of soil vapor extraction (SVE), bioventing, and natural attenuation. These remedies will be applied to various zones of deep soil contamination, either separately or sequentially, to accomplish cleanup goals in the most cost-effective manner. The proper application of these three technologies to the site would be determined after treatability studies and pilot tests are conducted to determine their relative effectiveness specific to the ST-12 deep soil. A fume incineration system will be required to destroy organic compounds in soil gas from the SVE or bioventing systems to comply with the applicable Maricopa County air quality requirements.

The major components of the selected remedy are:

- The SVE system will volatilize and extract organic contaminants from the subsurface soil for subsequent destruction in the fume incinerator. The system will operate until the concentration of benzene in the soil is reduced to cleanup levels.

- Bioventing will induce air flow into the subsurface soil to stimulate the biodegradation of organic contaminants by indigenous soil microorganisms. The quantity of air extracted from the soil will be controlled to maximize biodegradation and minimize volatilization of contaminants.

- Natural attenuation will include bench-scale biodegradation studies, contaminant transport modeling, periodic soil monitoring, and other evaluations needed to predict the rate of contaminant attenuation, and will confirm that these natural biodegradation processes are proceeding at a rate consistent with meeting remedial action objections (RAO), described in more detail in Section 5.4.

- The selected remedy will mitigate future migration of chemicals of concern (COC) to groundwater, which presents the principal threat to human health at this site. The remedy will remain in operation until the concentrations of COCs are reduced to cleanup levels.

1.5 Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the RA, and is cost effective. This remedy uses permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. A 5-year review will apply to this action because this remedy will take greater than 5 years to reduce the hazardous substances remaining on site below cleanup levels.

This Record of Decision Amendment for Operable Unit Number Two at Williams Air Force Base, Arizona may be executed and delivered in any number of counterparts, each of which when executed and delivered shall be deemed to be an original, but such counterparts shall together constitute one and the same document.

Alan K. Olsen — 9/17/96

Alan K. Olsen, Director — Date
U.S. Air Force, Base Conversion Agency

Gary Baker for — 8-16-96

Julie Anderson, Director — Date
Federal Facilities Cleanup Office
U.S. Environmental Protection Agency, Region IX

Russell F. Rhoades — 10/1/96

Russell F. Rhoades, Director — Date
Arizona Department of Environmental Quality

Rita Pearson — 11/4/96

Rita Pearson, Director — Date
Arizona Department of Water Resources

2.0 Decision Summary

2.1 Highlights of Community Participation

Ongoing Public Involvement. A community relations plan for the Base was issued in February 1991 (IT, 1991c) and updated in March 1995. This plan listed contacts and interested parties throughout the USAF, government, and the local community. The plan also established communication channels to ensure timely dissemination of pertinent information to the surrounding community through mailings, public announcements in the local newspaper, public meetings, public comment periods, public service announcements, and the establishment of information repositories in local libraries.

Early in the IRP, the Base established a Technical Review Committee (TRC) to provide review and offer comment and recommendations on the progress of the cleanup effort. The TRC included representatives from the USAF and other governmental agencies as well as appointed representatives from the surrounding communities. Governmental agencies represented included EPA Region IX, the ADEQ, ADWR, and the Maricopa County Department of Health.

With the advent of Base closure, the TRC was expanded to include additional community stakeholders and is now called the Restoration Advisory Board (RAB). Much the same as a TRC, the RAB acts as a forum for discussion and exchange of information regarding cleanup between the installation, governmental agencies and the community. However, because the RAB provides for an expanded and more diverse membership representing the community, a greater opportunity is afforded to those directly affected by the cleanup process to participate and provide input. This input will be especially valuable as decisions are made regarding transfer and end uses of Base property.

An Administrative Record that contains the documents relating to investigation and cleanup activities proposed for the Base has been established and is available for public inspection as part of the information repositories at the Gilbert Public Library, Gilbert, Arizona and the Base Conversion Agency (Williams AFB), Mesa, Arizona.

Public Involvement Specific To OU-2 Amendment for Deep Soil. The recommended remedy for the OU-2 amendment for deep soil is described in the OU-2 Amendment Proposed Plan. Concurrently, this document was made available to the public in the

Administrative Record. The notice of their availability was published in the *Arizona Republic/Phoenix Gazette* on February 12, 1996, an action which coincided with the beginning of the 30-day public comment period.

The USAF has met the community relations requirements of CERCLA Sections 113 and 117 in the remedy selection process for OU-3 through the following activities. The OU-3 RI/FS which outlined the actions for the deep soil included in this OU-2 amendment was released for public review on June 26, 1995. A public meeting was held February 21, 1996 at the former Williams AFB in Building 1, Mesa, Arizona to discuss the proposed remedial alternatives. A fact sheet describing the proposed plan was distributed at the public meeting, placed in the information repositories, and to other interested individuals upon request. There were no written comments received during the public comment period but the verbal comments and the corresponding USAF responses are included in the Responsiveness Summary (Chapter 11.0).

3.0 Scope and Role of Operable Unit

As with many Superfund sites, the environmental problems at Williams AFB are complex. As a result, the USAF has organized the work into the following OUs.

- OU-1 addresses soil and groundwater contamination at the following ten sites:
  - Landfill (LF-04)
  - Fire Protection Training Area No. 1 (FT-03)
  - Northwest Drainage System (SD-10)
  - Radioactive Instrumentation Burial Area (RW-11)
  - Pesticide Burial Area (DP-13)
  - Hazardous Materials Storage Area (SS-01)
  - Underground storage tanks (UST) at four area (ST-05, ST-06, ST-07, ST-08).

- OU-2 addresses soil and groundwater at the LFSA (ST-12). Deep soil at ST-12 is added to OU-2 by this amendment.

- OU-3 addresses soil and groundwater at the following two sites:
  - Fire Protection Training Area No. 2 (FT-02)
  - Southwest Drainage System (SD-09) (soil only).

- OU-4 addresses investigations of contamination at 11 sites.

- OU-5 addresses removal actions at eight sites.

The USAF, in conjunction with EPA and the State of Arizona, has selected cleanup remedies for OU-1, OU-2, and OU-3. These remedies are specified in their respective RODs. The deep soil at ST-12 will be addressed in this RODA. Investigations at OU-4 and removal actions at OU-5 have been completed and reports are being prepared to document the activities at these sites.

OU-1 includes soil and groundwater at ten sites. Of the ten sites within OU-1, only the soil at the Landfill (LF-04) presented an unacceptable risk to human health and the environment. Surface soil at LF-04 contaminated with beryllium and the pesticide dieldrin at concentrations above remediation goals were covered with a permeable cap over the Landfill. This remedy limited human exposure to dieldrin and beryllium-contaminated surface soil, controlled natural erosion processes, and included warning signs and perimeter fencing. This remedy has been completed and soil and groundwater for OU-1 is in the operation and maintenance (O&M) phase.

The principal risks to human health and the environment at OU-2 result primarily from contamination of soil and groundwater by JP-4 and its constituents (e.g., benzene, toluene), although other organic compounds have also been detected at the site. The ROD for OU-2, signed in December 1992, specified a remedy involving a combination of SVE with bioenhancement to remediate shallow soil, and groundwater extraction and treatment via air stripping with emission abatement to remediate the contaminated groundwater. The remedial design (RD)/RA phase for OU-2 was conducted with a pilot study/demonstration study on the treatment of contaminated groundwater and a pilot study on the treatment of contaminated soil. The shallow soil has been remediated via the Phase I SVE remedy. Source control for groundwater is continuing and the treatment remedy is being reviewed.

Investigation and modeling of deep soil at ST-12 presented in OU-3 RI projected that contaminants in soil will migrate to the groundwater, providing a continuing source of contaminants. Deep soil at ST-12 is being incorporated into OU-2 to initiate action to abate threats to human health and the environment, by mitigating COC migration to groundwater. The remedy selected in this RODA is designed to be consistent with any subsequent remedies and planned future actions at the Base proposed in all subsequent RODs.

4.0 Summary of Site Characteristics

Chapter 4.0 provides an overview of the assessments conducted during the RI to characterize deep soil at ST-12. Investigations on first 25 feet of soil and groundwater are summarized in the OU-2 ROD (IT, 1992b). Investigations on deep soil at ST-12 were conducted as part of the OU-3 efforts and details of these investigations are presented in the OU-3 RI (IT, 1994). This summary presents the following information:

- Quantity, types, and concentrations of hazardous substances
- Estimated volume of contaminants
- Lateral and vertical extent of contamination
- Mobility of identified contaminants
- Potential surface and subsurface pathways of contaminant migration.

4.1 Deep Soil at Liquid Fuels Storage Area

Deep soil investigations at ST-12 were limited to determining the levels of organic constituents of total petroleum hydrocarbons (TPH) using a JP-4 standard, benzene, toluene, ethyl benzene, and xylene (BTEX), and total organic compound (TOC) as specified in the approved work plan and field sampling plan addendums for OU-3 (IT, 1993a,b). This section summarizes the results of 16 soil borings installed in 1993. The nature of contamination at ST-12 is from JP-4 contamination as specified in the OU-2 RI report (IT, 1992a). The extent of JP-4 contamination to a depth of 25 feet was identified in the OU-2 ROD (IT, 1992b) in four areas. The deep soil investigations focused on these areas to better define the extent of contamination at depths exceeding 25 feet. These areas, shown in Figure 1-2, are associated with former Tank 688 (Area 1), former Tank 514 (Area 2), former Tank 538 and the former distribution line that led from Tank 538 south along distribution lines that have been removed between Tanks 538 and 555 (Area 3), and former location of tanks at Facility 548 (Area 4). The OU-2 FS report (IT, 1992c) further concluded that the worst-case dispersion of contamination migrating downward was at a 30-degree angle from vertical. This conclusion was based on data presented in the OU-2 RI report (IT, 1992a).

Soil has been classified as contaminated if the JP-4 concentration exceeds 7,000 milligrams per kilogram (mg/kg) as set forth in the Arizona Department of Environmental Quality (ADEQ) UST soil cleanup levels (ADEQ, 1990). JP-4 results for the deep soil borings with JP-4 concentrations exceeding 100 mg/kg are presented in Figure 4-1. The last sample from each soil boring was taken at the approximate top of groundwater at 215 feet. Also, some

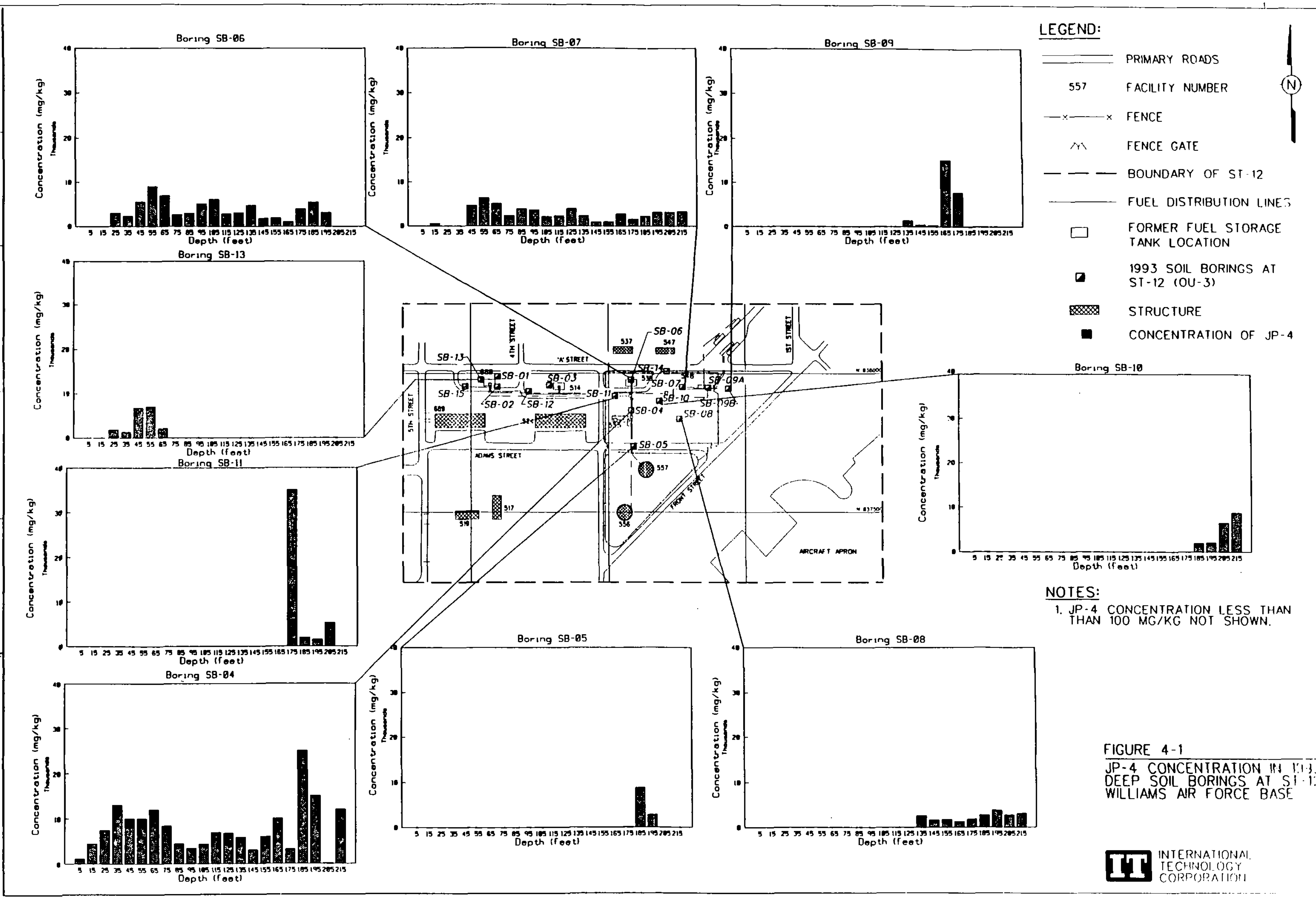


FIGURE 4-1
JP-4 CONCENTRATION IN 1993 DEEP SOIL BORINGS AT ST-12
WILLIAMS AIR FORCE BASE

DWG. NO.: 409877ES.043 | PROJ. NO.: 409877
INITIATOR: B. ANDERSON | PROJ. MGR.: W.CARTER
DRAFT. CHCK. BY: R. CLARK | ENGR. CHCK. BY: R. CLARK
STARTING DATE: 05/16/95 | DATE LAST REV.
DRAWN BY: P.JONES | DRAWN BY:
FILENAME: 409877ES.043 18:14:06 Jan. 15, 1996 Clay

samples were taken at depths less than 25 feet to confirm or deny the presence of contamination in the first 25 feet of soil.

The deep soil investigation at ST-12 clarified many of the conclusions drawn in the OU-2 RI report and provided new data regarding the extent of subsurface contamination. Results from the soil borings showed that the approximate dispersion angle of 30 degrees assumed in the OU-2 FS report (IT, 1992c) was exaggerated. Actual dispersion patterns were nearly vertical. Also, it was found that the higher concentrations were detected with depth. Such a distribution pattern of JP-4 (TPH) in the soil was likely created by a continuous release of JP-4 at, or near, the ground surface. Elevated contaminant concentrations were also periodically detected in isolated fine-grained layers above the water table.

Soil samples collected during the deep soil investigation at ST-12 were not analyzed for inorganic compounds. Previous investigations do not indicate significant concentrations of constituents involving inorganics in deep soil at ST-12 (IT, 1992c).

4.2 Contaminant Fate and Transport

As previously noted, the focus of the investigations at the site was contamination due to JP-4; therefore, this summary of fate and transport is restricted to behavior of organics in soil. Detailed discussions of contaminant fate and transport were presented in the OU-3 RI report (IT, 1994).

4.2.1 Contaminant Persistence in the Environment

Chemical persistence in environmental media is determined by the chemical's ability to move through a medium, to transfer from one medium to another, and to transform or degrade. These processes are controlled both by the chemical or element properties and the medium. Migration to groundwater can occur via water infiltration, dispersion, and diffusion. Sorption of chemicals onto soil particles or soil organic matter can reduce migration; similarly, chemically or biologically mediated transformation or degradation of chemicals can reduce migration.

The mobility of organic compounds within the soil is affected by chemical processes that are in part due to a chemical's volatility, octanol-water partition coefficient (a measure of the affinity of a chemical to partition from water to organic materials), water solubility, and concentration. In general, the more water insoluble a compound is, the more likely it is to adsorb on a sediment or organic surface. For several groups of compounds (including phenols, phthalates, and monocyclic aromatics such as benzene) volatilization, sorption and biodegradation are all prominent processes. The behavior of polynuclear aromatic hydrocarbons was found to be a function of the number of rings present. Important processes for this class of compound are sorption and aerobic and anaerobic biodegradation. The fate of chlorinated pesticides is determined by sorption, volatilization, and/or biotransformation.

4.2.2 Organics in ST-12

A site-specific unsaturated flow and multiphase transport model was developed to determine the potential downward migration of contaminants detected in deep soil boring soil samples at ST-12. As part of this effort, the model was used to determine (1) if JP-4 has the potential to move vertically or is in an immobile, residual state, (2) the rate of movement, if any, and (3) whether the BTEX components entering the aqueous phase would impact the uppermost water-bearing unit. The modeling effort focused on the unsaturated movement characteristics of the various phases present beneath ST-12. The information provided in this section summarizes the modeling input and results. A more thorough presentation of the input parameters, their derivation, model development, calibration and use, results, and discussions are provided in Appendix D of the OU-3 RI report (IT, 1994).

The model was run for a period of 100 years to estimate the long-term impacts to groundwater by JP-4. Modeling progressed under the assumptions that no biodegradation of the chemical components occurs, and that no RAs were in place. The model indicated that from ground surface to a depth of 60 or 70 feet, little movement of the JP-4 and its chemical components will occur. It appears to be essentially immobile. Definite movement was indicated by the model below a depth of 70 feet. However, the majority of the movement was predicted to occur within 25 years, with little additional movement observed after this time.

The model results indicate that JP-4 can be expected to accumulate on the groundwater surface, representing a source of contamination to the groundwater. The results project little JP-4 will be added to the groundwater after approximately 25 years. Any accumulated mass of JP-4 can be expected to contribute benzene to the groundwater system over time.

Using average groundwater flow velocities (0.021 feet per day) and an average aquifer thickness of 25 feet, an average benzene concentration in groundwater resulting from the movement of JP-4 through the subsurface soil is approximately 30 micrograms per liter (µg/L) (at boring SB-04). This average concentration occurs at a predicted time of approximately 25 years. By the end of the simulated time period (100 years), an average benzene concentration in groundwater is estimated to be approximately 0.4 µg/L. The method by which concentrations were calculated was unable to account for any additional benzene (or other chemical constituent) dissolving into groundwater from the JP-4 present on the groundwater surface. This phenomenon may account for an overall increase in the average concentrations by perhaps an order of magnitude.

Groundwater modeling efforts for deep soils was further extended to establish preliminary remediation goals (PRG) for benzene, toluene, naphthalene, and TPH. This modeling effort is discussed in the site risk chapter, because these PRGs were developed using health-based standards established in the OU-2 ROD (IT, 1992b).

5.0 Summary of Potential Site Risk

Deep soil (25 feet and deeper) at ST-12, which was part of OU-3, was not evaluated in the baseline human health risk assessment because there are no complete pathways by which the occupational or residential receptors would be exposed to the deep soil. The only potentially complete pathway is leaching of contaminants from the deep soil to the groundwater, and the remedy for contaminated groundwater is addressed by the ROD for OU-2 (IT, 1992b).

5.1 Chemicals of Potential Concern

The OU-2 ROD (IT, 1992b) addressed the health risks associated with the top 25 feet of soil at ST-12, and identified a number of COPC for the deep soil. There are no human health risks associated with the COPCs in deep soil at ST-12 because no direct exposure pathways exist from contaminated soil to potential receptors. Migration of deep soil contaminants to groundwater is the only potential exposure pathway to human receptors. There are no applicable or relevant and appropriate requirements (ARAR) for soil at ST-12 because no statutory mandated levels exist for contaminants in soil. To-be-considereds such as Arizona health-based guidance levels (HBGL) and risk-based calculated allowable concentrations are not pertinent requirements because they are predicated on exposure pathways that do not exist for ST-12 in this operable unit. Therefore, an approach was developed to calculate PRGs for soil contaminants based on their potential environmental impact on groundwater when measured at compliance points (IT, 1995).

The first step in the process of identifying COPCs for the deep soil was to consider the list of COPCs for subsurface soil identified in the OU-2 ROD (IT, 1992b) and listed in Table 5-1, then compare this list to the COCs selected for groundwater. A chemical was eliminated as a COPC for deep soil if it met any of the following exclusionary criteria.

- The chemical was not identified as a COC for groundwater.
- The chemical was determined to be not characteristic of site contamination (i.e., laboratory error, chemical not fuel-related) in the OU-2 FS.

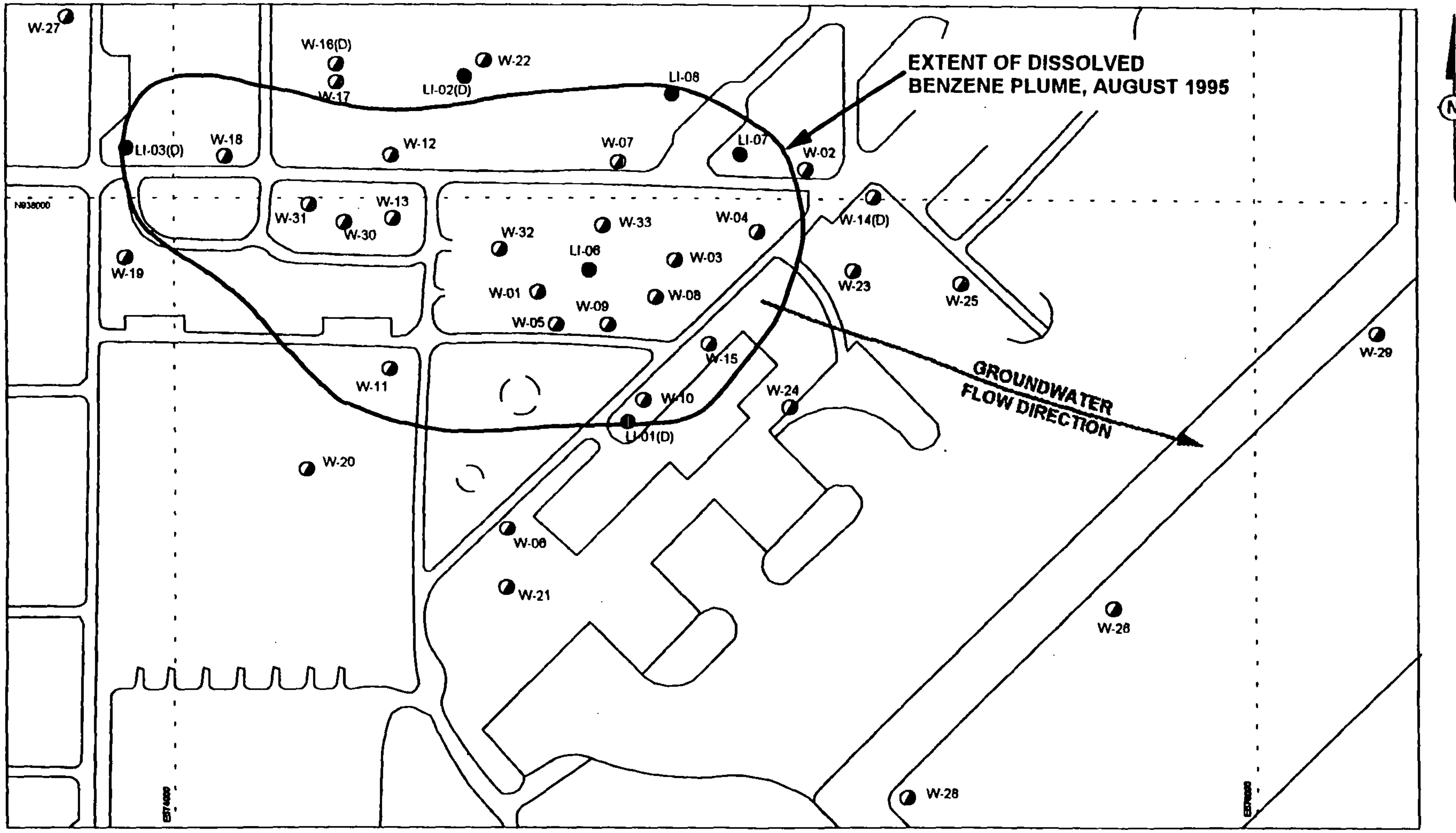
The rationale for eliminating individual chemicals as COPCs is also documented in Table 5-1. The table shows that benzene, naphthalene, and toluene were determined to be COPCs for deep soil. Each of these chemicals are constituents of JP-4.

Table 5-1

Evaluation of Chemicals of Potential Concern
ST-12 Deep Soil
Operable Unit 2, Williams Air Force Base

Chemicals of Potential Concern[a]	Basis for Elimination from Further Consideration
Organics	
Acetone	Not a COC for groundwater.
Benzene	Retained as a COPC for soil.
Bis(2-ethylhexyl)phthalate	Chemical is not fuel-related.
Chlorobenzene	Not a COC for groundwater.
1,2-Dichlorobenzene	Not a COC for groundwater.
1,3-Dichlorobenzene	Not a COC for groundwater.
1,4-Dichlorobenzene	Not a COC for groundwater.
Ethyl benzene	Not a COC for groundwater.
2-Hexanone	Not a COC for groundwater.
Methylene chloride	Not a COC for groundwater.
2-Methyl naphthalene	Not a COC for groundwater.
4-Methyl-2-pentanone	Not a COC for groundwater.
Naphthalene	Retained as a COPC for soil.
Phenol	Not a COC for groundwater.
Toluene	Retained as a COPC for soil.
Xylenes	Not a COC for groundwater.
Inorganics	
Antimony	Chemical is not fuel-related.
Cadmium	Not a COC for groundwater.
Lead	Not a COC for groundwater.

[a]Chemicals of potential concern (COPC) subsurface soil from OU-2 Record of Decision (IT, 1992b)
COC = Chemical of concern.



LEGEND:

- IT/CDM MONITORING WELL
- AV MONITORING WELL
- (D) DENOTES DEEP MONITORING WELL

SCALE:

0 250 500 FEET

FIGURE 5-1

GROUNDWATER CONTAMINANT PLUME AT ST-12, AUGUST 1995

LIQUID FUELS STORAGE AREA (ST-12)
WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION

5.2 Preliminary Remediation Goals

A computer modeling effort was conducted to establish PRGs for benzene, toluene, naphthalene, and TPH. The model was used to calculate the concentrations of benzene, toluene, and naphthalene in deep soil that would, upon migration, result in maximum future groundwater concentrations at the compliance point approximately equal to the OU-2 remediation goals. The OU-2 ROD (IT, 1992b) established remediation goals for benzene, toluene, and naphthalene in groundwater at 5, 1,000, and 28 µg/L, respectively. Soil concentrations that result in these predicted groundwater concentrations at the compliance points are proposed as the deep soil PRGs. The model was also used to estimate the TPH concentration below which no further bulk movement of residual JP-4 would be expected.

The following assumptions form the basis upon which PRGs were calculated for COPCs using the vadose zone and groundwater transport models:

- The aquifer under ST-12 was assumed to be initially uncontaminated, even though the groundwater underneath the deep soil is contaminated with JP-4, and a significant layer of free-phase JP-4 is floating on the surface of the groundwater. Groundwater contamination beneath ST-12 is addressed by the selected remedy for OU-2. A groundwater pilot study/demonstration study at ST-12 is ongoing to determine the effectiveness of the selected groundwater remedy for OU-2.

- A groundwater compliance point was established at a distance from the major source of contamination represented by the line between or through monitoring wells SS01-W26, SS01-W28, and SS01-W29 (Figure 5-1). This compliance point was established to determine the allowable extent of plume migration in groundwater. The final compliance point for determining when all RAs have been completed will be established during the RD/RA phase.

- A biodecay factor was neither appropriate nor used for modeling the transport of COPCs in soil. A soil biodecay factor was evaluated as a component of some of the remedial alternatives presented in Chapters 3.0 and 4.0 of the OU-3 FS (IT, 1995).

- A biodecay factor was appropriate and used in modeling the transport of COPCs in groundwater. The longest half-life for any COPC identified in the literature search was 2 years for benzene (Howard, et al., 1991). An iterative approach was then initiated with this period as a point of departure to determine the effects of different biodecay factors on modeling results. Based on this approach, a biodecay half-life of 10 years was used for all COPCs. The 10-year half-life is considered conservative. The appropriateness of the 10-year half-life can be verified based on natural attenuation treatability tests for groundwater.

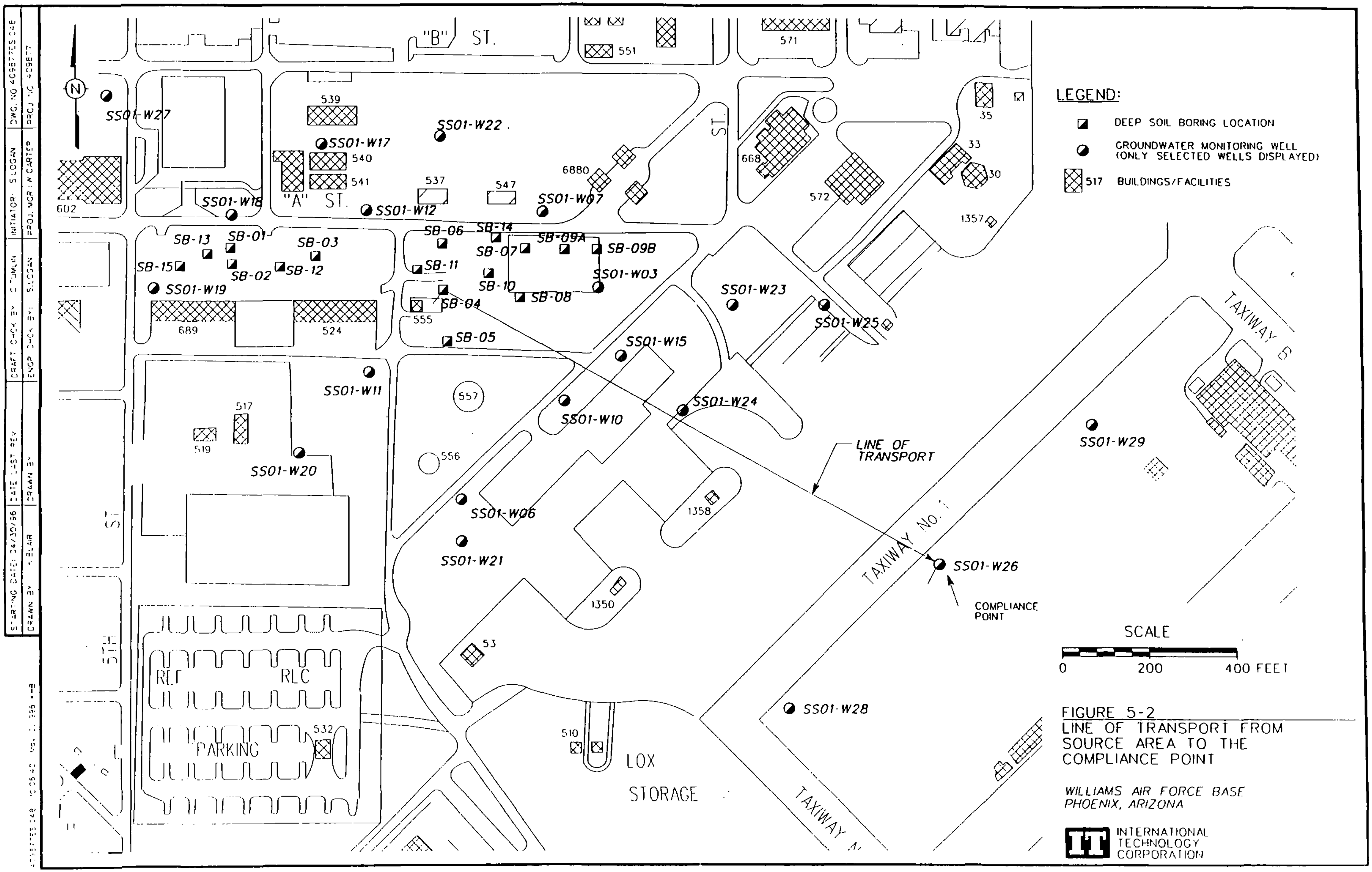


FIGURE 5-2
LINE OF TRANSPORT FROM SOURCE AREA TO THE COMPLIANCE POINT

WILLIAMS AIR FORCE BASE
PHOENIX, ARIZONA

INTERNATIONAL TECHNOLOGY CORPORATION

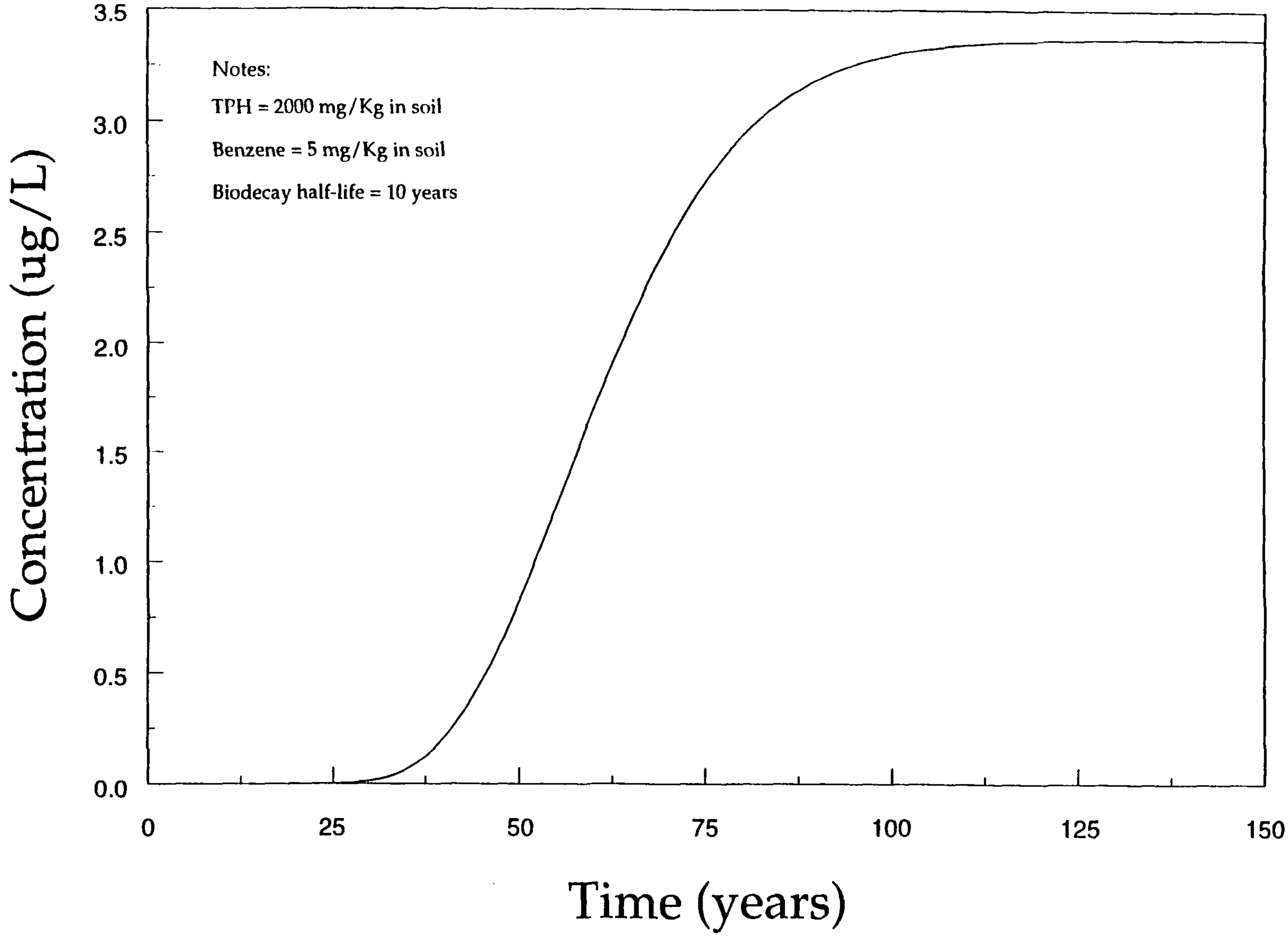


Figure 5-3

Concentration of Benzene in Groundwater at the Compliance Point
Using the Modeled PRG value of 5 mg/Kg Benzene in Soil.

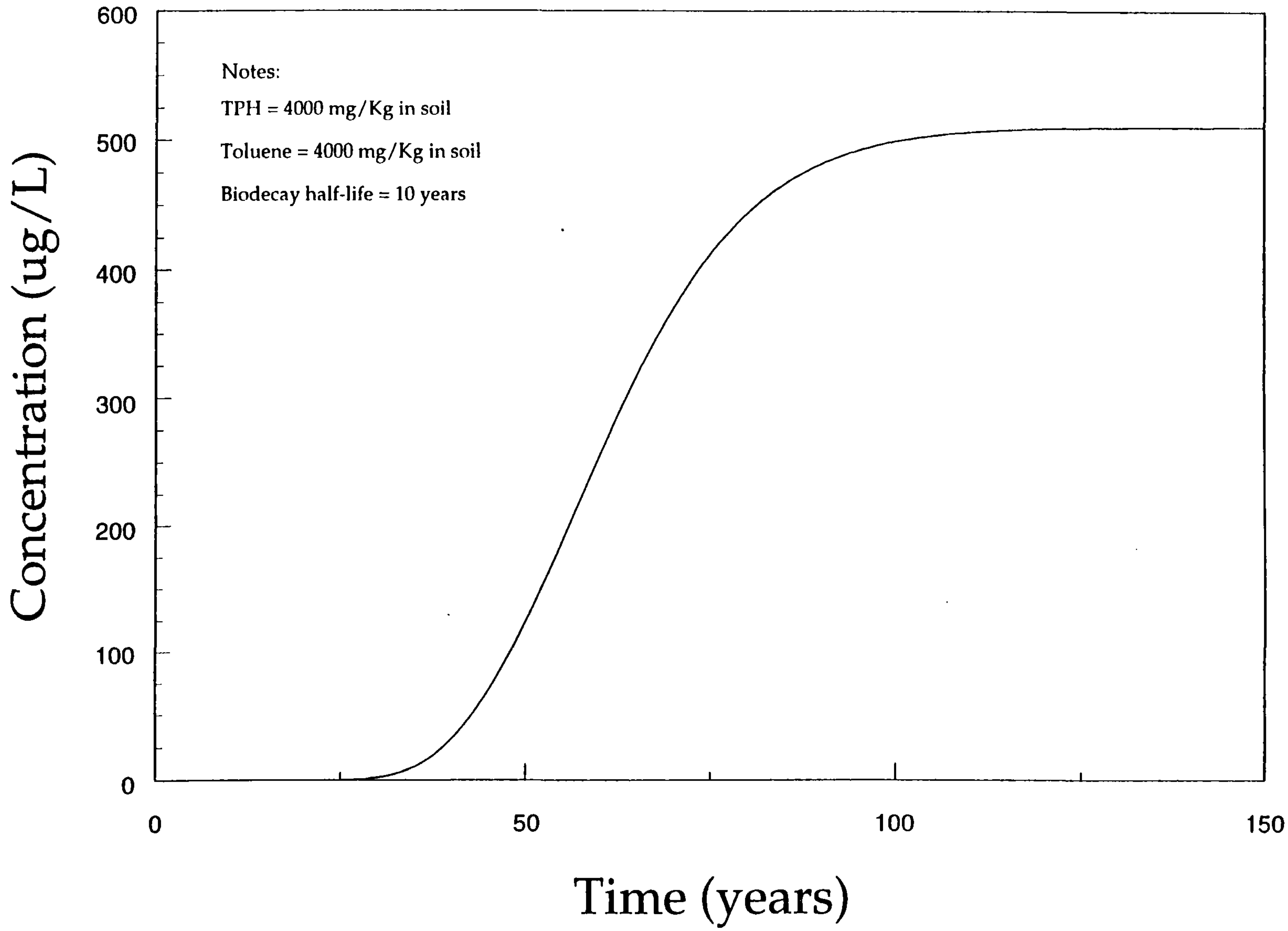


Figure 5-4

Concentration of Toluene in Groundwater at the Compliance Point
Using the Modeled PRG value of 4000 mg/Kg Toluene in Soil.

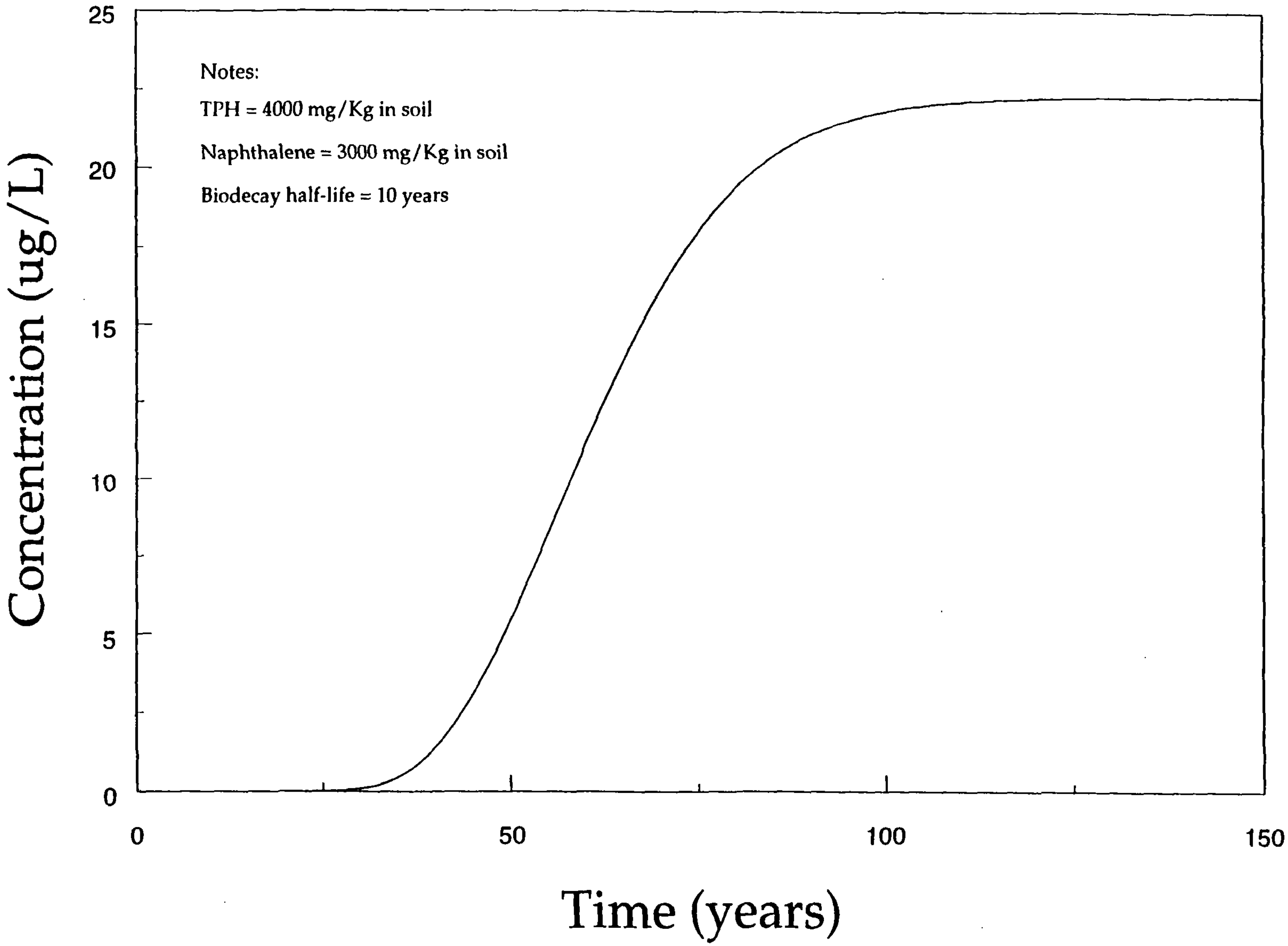


Figure 5-5

Concentration of Naphthalene in Groundwater at the Compliance Point
Using the Modeled PRG value of 3000 mg/Kg Naphthalene in Soil.

Table 5-2

Determination of Chemicals of Concern and Cleanup Levels in Deep Soil
Liquid Fuels Storage Area (ST-12)
Operable Unit 2, Williams Air Force Base

Chemicals of Potential Concern	Base-Specific Background Range or Value (mg/kg)	Value of Range of Detected Concentrations (mg/kg)	PRG[a] (mg/kg)	UCL[b] (mg/kg)	Decision Basis
Benzene[c]	NA[d]	0.001 to 890	5[e]	31	Requires action to meet PRG.
Naphthalene	NA	3.5 to 14	3000	10	UCL concentration below PRG.
Toluene	NA	0.001 to 1500	4000	91	UCL concentration below PRG.
TPH as JP-4[f]	NA	0.42 to 360,000	2000[e]	5100	Requires action to meet PRG.

[a]Preliminary remediation goals based on modeling concentration of contaminants that would result in concentrations at the compliance points greater than action levels for groundwater (OU-2 ROD).
[b]UCL concentrations are calculated using all available deep soil data.
[c]Chemical of concern for ST-12 deep soil.
[d]NA - Not available.
[e]Target cleanup level.
[f]TPH is parameter of concern for ST-12 deep soil.

field data (e.g., groundwater elevation data). The determination of COCs and their respective cleanup levels in deep soil at ST-12 are presented in Table 5-2.

5.4 Remedial Action Objectives

The objectives of conducting RAs in the deep soil at ST-12 are to reduce the time required for groundwater cleanup and to remove sources of JP-4 in deep soil that may continue to impact groundwater at ST-12, thereby minimizing the cost of remediating the entire site. The cleanup level for deep soil remediation is 5 mg/kg for benzene. In addition, TPH will be reduced to an initial target concentration of 2,000 mg/kg. These concentrations may be revised based on the results of soil and groundwater treatability studies, and other field data (e.g., groundwater elevation data), with the concurrence of the Parties to the Federal Facilities Agreement (FFA).

6.0 Description of Alternatives

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a process has been established to develop, screen, and evaluate appropriate remedial alternatives. A wide range of cleanup options were considered for RA for deep soil at ST-12.

The initial process options considered during the preliminary screening process are presented in Figure 6-1. The process options were evaluated, and retained or eliminated from further consideration on the basis of technical feasibility. Figure 6-1 presents the rationale for eliminating process options.

A second screening step was then performed to evaluate the remaining process options on the basis of implementability, effectiveness, and cost. The result of this screening process was intended to select one representative process option for each technology type for detailed analysis. The secondary screening was a two-step process. First, the process options retained from preliminary screening were ranked according to the previously mentioned three criteria to eliminate those options that were obviously inappropriate. The results of this step are presented in Figure 6-2. After this evaluation process, the following remedial alternatives were screened for contaminated deep soil at ST-12:

- Alternative ST12-1: No Action
- Alternative ST12-2: Natural Attenuation
- Alternative ST12-3: SVE
- Alternative ST12-4: Bioventing
- Alternative ST12-5: Synergistic alternative, SVE, Bioventing, and Natural Attenuation.

These alternatives were developed based on site-specific needs and evaluated using the nine criteria developed by EPA to address CERCLA requirements. The evaluation criteria presented in Figure 6-3 are used to determine the most appropriate alternative. The following sections present detailed descriptions of the previously noted remedial alternatives.

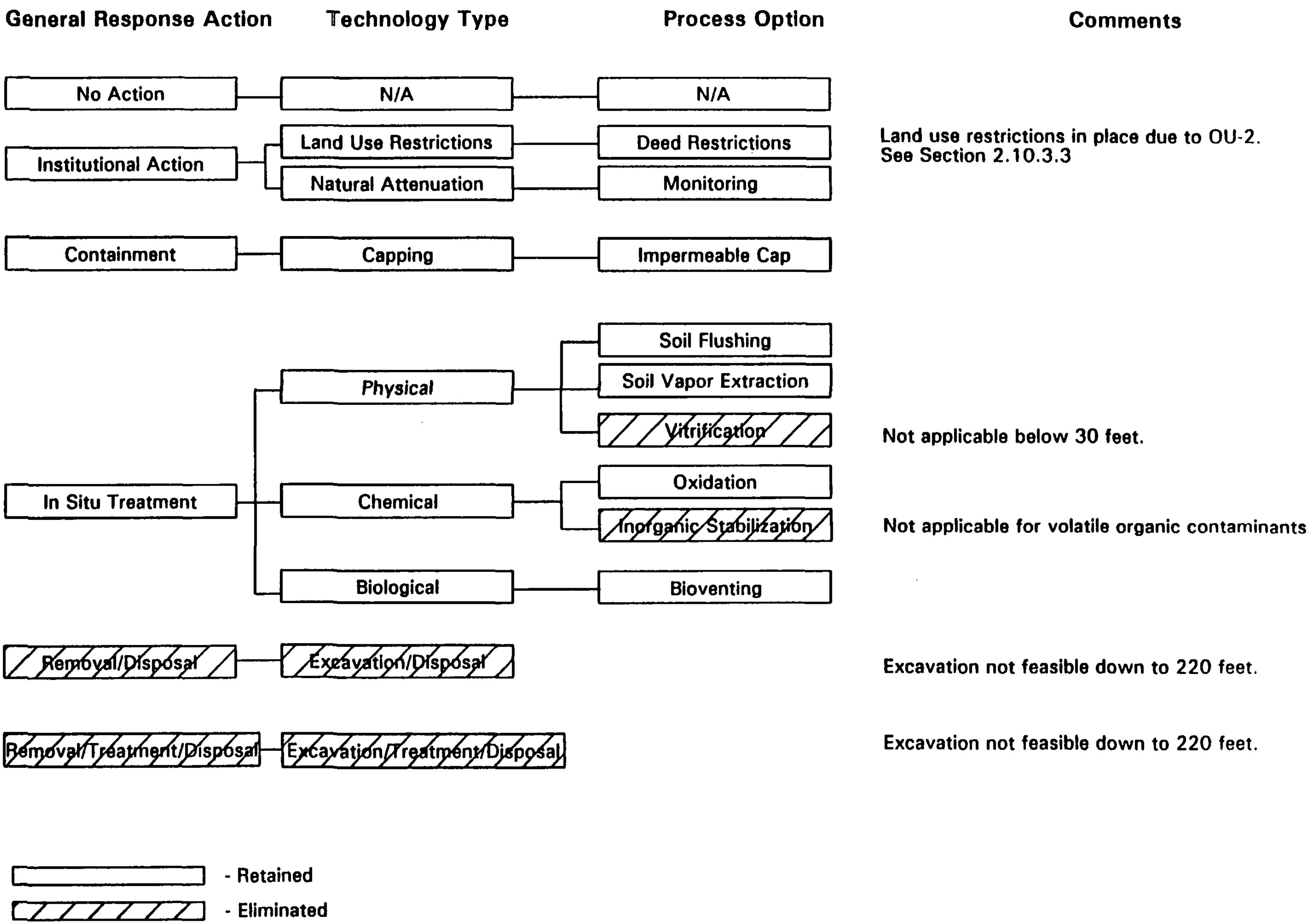


Figure 6-1. Initial Screening - Deep Soils at ST-12

6.1 Alternative ST12-1: No Action

6.1.1 Source Treatment Component

The no-action alternative is evaluated as a remedial alternative in accordance with EPA guidance to serve as a baseline for comparison with the other alternatives. This alternative would leave the contaminated soil in place with no additional means to prevent accidental exposure other than those measures already in place, such as fencing. Contaminants in the subsurface soil may naturally attenuate. However, under Alternative ST12-1, the monitoring and modeling required to evaluate the progress of natural attenuation would not be performed. A review/reassessment of the site conditions would be performed in accordance with Section 300.430 of the National Contingency Plan (NCP) at 5-year intervals.

6.1.2 Source Containment Component

This alternative does not incorporate a containment component that would restrict the migration of contaminants from soil to groundwater.

6.1.3 Groundwater Component

This remedial alternative does not incorporate a groundwater extraction and treatment component.

6.1.4 General Components

No institutional controls will be utilized in the implementation of this alternative. Groundwater at the site would be sampled annually and analyzed for specified chemicals and/or indicator parameters.

There are no implementation requirements of concern for this alternative.

The initial risk in implementing the remedial alternative is very low because no RA would be taken at the site that could create potential exposures.

The residual risk for this alternative is higher than for the other alternatives because no action would be taken to prevent the migration of contaminants to groundwater. Long-term groundwater monitoring would be required to ensure that contaminants left in place do not. impact groundwater.

There are no capital costs associated with this alternative. Initial capital cost of Alternative ST12-1 is $0. The annual O&M cost is $0.4 million. The annual O&M cost includes $0.3 million for the cost of 5-year site reviews allocated over each year, and $0.4 million per year for operation of the OU-2 groundwater remediation system. The estimate of operating cost for the OU-2 groundwater remediation system was obtained from the OU-2 ROD (IT, 1992b). Detailed O&M costs for Alternative ST12-1 are presented in Appendix A. The net present worth of Alternative ST12-1 was $0.7 million for O&M costs associated with 5-year site reviews, and $9.6 million for O&M costs of the OU-2 groundwater remediation system for the estimated 30 years required to meet remediation goals. This results in a total net present worth for Alternative ST12-1 of $10.3 million.

6.1.5 Compliance with ARARs

Because this alternative does not incorporate any active remedial measures, ARARs are not applicable.

6.2 Alternative ST12-2: Natural Attenuation

6.2.1 Source Treatment Component

Under Alternative ST12-2, no direct RA would be implemented. Contaminants in the deep soil may naturally attenuate, resulting in a reduction in the mass of contaminants. The aerobic degradation of fuel-contaminated soil by in situ remedial measures such as bio-remediation and bioventing has been well demonstrated and supported in the scientific lite-rature. However, the anaerobic degradation of fuel-contaminated soil by natural processes is not as well documented, and is dependent on a number of site-specific characteristics. Therefore, monitoring and modeling efforts would be conducted throughout the natural attenuation process to confirm that benzene and TPH degradation is proceeding at rates consistent with RAOs described in Section 5.4.

6.2.2 Source Containment Component

This alternative does not incorporate a containment component that would restrict the migration of contaminants from soil to groundwater.

6.2.3 Groundwater Component

This remedial alternative does not incorporate a groundwater extraction and treatment component because groundwater was addressed in the OU-2 ROD.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Economics
No Action	N/A	N/A	Easily implemented	Potentially effective over an extended duration due to natural attenuation of contaminants.	Least costly alternative
Institutional Action	Land Use Restrictions	Deed Restrictions	Already implemented as a component of the OU-2 ROD selected remedy.	Limits risk by controlling direct exposure to contaminants. Does not prevent migration or actively treat contaminants.	Inexpensive to implement
	Natural Attenuation	Monitoring	Easily implemented	Potentially effective over an extended duration. Effectiveness can be evaluated by lab treatability tests, modeling and monitoring to confirm degradation rates.	Inexpensive to implement
Containment	Capping	Impermeable Cap	Implementable.	Not effective in mitigating migration of free phase JP-4.	Moderately expensive
In Situ Treatment	Physical	Soil Flushing	Difficult to maintain hydraulic control. Potential contaminant solubility and mass requires injection & treatment of large volumes of water.	Potentially effective. May require injection of environmentally significant chemicals to improve the solubility of contaminants.	Expensive. Significant groundwater extraction and treatment system required.
		Soil Vapor Extraction	Implementable. Field pilot tests required.	Effective for remediation of fuel hydrocarbons in permeable soils.	Economical method to remediate vadose zone. Normally requires air pollution controls.
	Chemical	Oxidation	Difficult to implement. Difficult to transport oxidants to deep soils. Oxidants will react with soils	Limited effectiveness with fuel hydrocarbons.	Not cost effective. Large amounts of oxidizing agent required for highly contaminated soils.
	Biological	Bioventing	Implementable. Field pilot tests required.	Effectiveness depends on site-specific characteristics such as microbial population, soil moisture, pH, nutrients, presence of inhibitory toxicants. Generally effective for removal of JP-4.	Economical method to remediate vadose zone. Air pollution controls not normally required.

- Retained

- Eliminated

fig6-2.drw/ltd/09-28-95

Figure 6-2. Secondary Screening - Deep Soils at ST-12

THRESHOLD CRITERIA

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Requires the assessment of alternatives to determine how they will provide human health and environmental protection from the risks present at a site by eliminating, reducing, or controlling the hazardous material detected during the Remedial Investigation.

COMPLIANCE WITH ARARs

Requires the assessment of alternatives to determine how ARARs meet the requirements under federal environmental laws and state environmental or facility siting laws.

PRIMARY BALANCING CRITERIA

LONG-TERM EFFECTIVENESS AND PERMANENCE

This criterion requires the evaluation of residual risks remaining at a site after completion of the remedial action.

REDUCTION OF TOXICITY, MOBILITY, AND VOLUME

This criterion addresses the statutory preference for selecting remedial actions that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances at a site by evaluating the extent to which this is achieved by each alternative.

SHORT-TERM EFFECTIVENESS

This criterion evaluates a remedial alternative's impact on human health and the environment during implementation

IMPLEMENTABILITY

This criterion evaluates both the technical and administrative feasibility of implementing an alternative including the availability of key services and material required during its implementation.

COST

Under this criterion, capital costs, annual operation and maintenance costs and the net present value of capital O&M costs are assessed for each alternative.

MODIFYING CRITERIA

STATE ACCEPTANCE

This criterion addresses the statutory requirement for substantial and meaningful state involvement. Evaluation of this criterion is conducted by EPA and addressed during development of the record of decision.

COMMUNITY ACCEPTANCE

This criterion assesses the community's apparent preference for, or concerns about, the remedial alternatives. This process is conducted by EPA and addressed during development of the record of decision.

Figure 6-3. Remedial Alternative Evaluation Criteria

6.2.4 General Components

Natural attenuation would be in operation under the institutional action remedy (Figure 6-1) and can be differentiated from the no-action remedy, Alternative ST12-1, because this alternative would utilize biodegradation studies, modeling, and other evaluations to estimate the rate at which natural biodegradation processes would attenuate the concentration of benzene in the environment. These estimates would be used to technically evaluate the suitability of natural attenuation as a remedial measure in comparison to active treatment alternatives. Sampling and analysis would also be conducted throughout the natural attenuation period to confirm that benzene and JP-4 degradation is proceeding at rates consistent with meeting RAOs. The evaluation and implementation of the no-action alternative does not consider these technical factors and involves only a limited monitoring effort. Natural attenuation has been chosen as the selected remedy at CERCLA sites where active remedial measures are considered either technically impractical, or would not significantly accelerate remediation time frames.

Over an extended period of time, natural biodegradation processes should continue to reduce the benzene and TPH concentrations in soil to protective levels. However, significant migrations of JP-4 constituents to groundwater could occur from highly contaminated zones before natural biodegradation processes reduce COCs to PRGs. Institutional controls implemented as a component of the OU-2 selected remedy could be left in place until a determination is made that any potential residual risks are no longer significant. The OU-2 groundwater remediation system would continue to operate until RAOs are achieved for soil and groundwater at ST-12.

The initial capital cost of Alternative ST12-2 is $0.2 million. The annual O&M cost for this alternative includes $0.2 million per year for sampling, analysis, and data evaluation associated with monitoring the progress of natural attenuation in soil and groundwater, and $0.4 million per year for operation of the OU-2 groundwater remediation system. This results in a total O&M cost of $0.6 million per year. Detailed O&M costs for Alternative ST12-2 are presented in Appendix A. The net present worth of Alternative ST12-2 includes $5.1 million for capital and O&M costs associated with natural attenuation studies, and $9.6 million for the operation of the OU-2 groundwater remediation system for the estimated 30 years required to meet remediation goals. It may be noted that the modeling efforts to determine compliance in groundwater (Appendix F, OU-3 FS) assumed that a groundwater pump and treatment system for OU-2, working in conjunction with natural attenuation in groundwater, would result in compliance. This model also assumed that contamination in deep soil would not be remediated or attenuated naturally and would be leaching to groundwater. Thus, the modeling effort assumed that natural attenuation, not in isolation, but in conjunction with the groundwater treatment system, would require 30 years; therefore, the 30 years required by the groundwater treatment system for OU-2 to be in compliance is included in the cost estimates for the natural attenuation alternative (ST12-2). This results in a total net present worth for Alternative ST12-2 of $14.7 million.

6.2.5 Compliance with ARARs

The ARARs appropriate for this alternative are presented in Appendix B.

The action-specific ARAR concerning air emissions during remediation is not applicable to Alternative ST12-2 because this alternative will not generate any air emissions.

The action-specific ARAR concerning surface water control is considered an appropriate requirement. The alternative will meet this requirement by providing storm water collection in areas where soil cuttings are stored.

The action-specific ARAR concerning on-site container storage is an applicable requirement. The alternative will comply with the requirements of Resource Conservation and Recovery Act (RCRA) Section 40 Code of Federal Regulations (CFR) 264 concerning the handing, inspection, and maintenance issues associated with the storage of soil cuttings.

The action-specific ARAR concerning concentration limits on treated water discharged to a publicly owned treatment works (POTW) is not applicable to Alternative ST12-2 because this alternative will not generate any water discharge.

6.3 Alternative ST12-3: Soil Vapor Extraction

6.3.1 Source Treatment Component

This alternative would volatilize contaminants from the subsurface by imposing a vacuum on the subsurface soil through a series of vadose zone extraction wells. The contaminants in the extracted soil gas would subsequently be destroyed by a fume incineration system. A typical process flow diagram for an SVE system is presented in Figure 6-4.

Based on the nature and extent of contamination determined in the remedial investigation, a preliminary design was calculated for a SVE well network. This could consist of 33 4-inch

DWG NO.: 409877-B-18
PROJ. NO.: 401877
INITIATOR: W. ANDERSON
PROJ. MGR.: W. CARTER
DRAFT CHCK. BY:
ENGR. CHCK. BY: K. TRUONG
DATE LAST REV.:
DRAWN BY:
STARTING DATE: 5/23/95
DRAWN BY: P. JONES
4018771B 9/29/95 3:45PM RMK

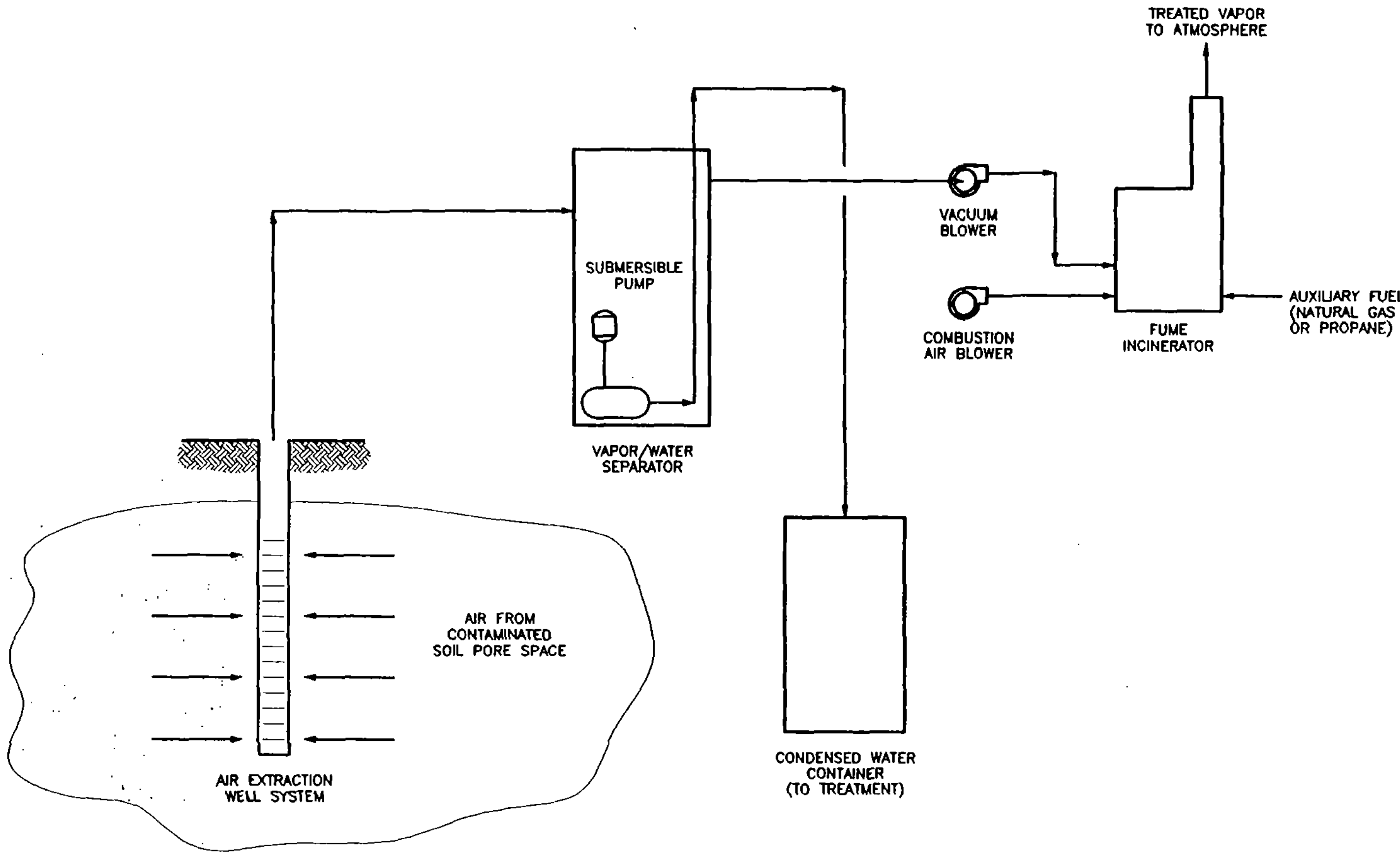


FIGURE 6-4
SOIL VAPOR EXTRACTION (SVE) SYSTEM
CONCEPTUAL FLOW DIAGRAM
DEEP SOILS AT LIQUID FUELS
AREA (ST-12)
OU-2, WILLIAMS AFB

INTERNATIONAL
TECHNOLOGY
CORPORATION

extraction wells screened over varying depths, and 11 4-inch-diameter passive vent wells that will provide a conduit for air into the deep soil formations. The cost estimates in this RODA are based on these preliminary designs. The final number of wells will be based on the results of soil and groundwater treatability studies, with the concurrence of the Parties to the FFA. The numbers and costs stated herein could therefore change. The vacuum system would consist of two vacuum exhausters rated for 18 inches of vacuum with a combined flow capacity of approximately 2,000 standard cubic feet per minute (scfm). The fume incineration system would be rated for a 90 percent destruction efficiency at 3,000 scfm. Fume incineration was selected over carbon adsorption as the air pollution control technology because the high concentrations of organics present in the extracted soil gas during the early periods of SVE system operation would consume large quantities of activated carbon, making this option economically infeasible. Water entrained in the extracted air would be removed by an air/water separator on the SVE skid. The water would be collected in a 55-gallon drum or a tote tank for subsequent transportation to and treatment by the groundwater treatment system at ST-12. The quantity of extracted water is anticipated to be very small, based upon the results of the SVE pilot test conducted on the shallow soil at ST-12. Details pertaining to the conceptual design for the SVE treatment system and estimating the duration of RA are presented in Appendix E2 of the OU-3 FS (IT, 1995).

It is estimated that the SVE system could achieve PRGs for benzene and TPH in approximately 8 years. Approximately 21,400 kg of benzene and 1,885,750 kg of TPH would have to be extracted from the deep soil to reach PRGs.

6.3.2 Source Containment Component

The remedial alternative does not incorporate a groundwater extraction and treatment component because groundwater was addressed in the OU-2 ROD (IT, 1992b).

6.3.3 Groundwater Component

The remedial alternative does not incorporate a groundwater extraction and treatment component because groundwater was addressed in the OU-2 ROD (IT, 1992b).

6.3.4 General Components

Short-term risks would be minimal because air emissions would be controlled. Fume incineration is an extremely effective air pollution control technology. A 90 percent destruction efficiency would ensure that Alternative ST12-3 would comply with ARARs concerning volatile organic compounds (VOC) emissions from remediation operations. Risk to workers from exposure during well drilling and trenching operations can be controlled by proper protective equipment. Short-term risks include potential release of contaminants in the event the air pollution control system malfunctions. However, the incorporation of operating alarms and interlocks into the treatment system design would mitigate this problem. There is a potential for workers to be exposed to fugitive contaminant vapors during operation of the system. SVE is a technically straightforward and well-proven process and should be reliable in performing as designed.

Periodic monitoring of the extracted air prior to emission control could be used to monitor the progress of remediation by estimating the rate of contaminant removal and the total mass of contaminants removed. Periodic monitoring of residual contaminant levels in the soil would be necessary to determine when the RA is complete. No long-term management, monitoring, or periodic site reviews would be required after remedial activities are complete.

The initial capital cost of Alternative ST12-3 is $2.6 million. The annual O&M cost for this alternative includes $0.6 million per year for operation of the SVE treatment system, and $0.4 million per year for operation of the OU-2 groundwater remediation system. This results in a total O&M cost of $1.0 million per year. Detailed annual O&M costs are presented in Appendix A. The net present worth of Alternative ST12-3 includes $7.1 million for capital and O&M costs associated with construction and operation of the SVE system, and $2.8 million for the operation of the OU-2 groundwater remediation system for the estimated 8 years required to meet remediation goals. This results in a total net present worth for Alternative ST12-3 of $9.9 million.

6.3.5 Compliance with ARARs

The ARARs appropriate for this alternative are presented in Appendix B.

The location-specific ARAR concerning the protection of significant archaeological artifacts is a relevant and appropriate requirement. Prior to the initiation of any remedial activities at the site, remedial plans will be reviewed with the State Historic Preservation Officer (SHPO) to obtain his approval. If any obvious archaeological artifacts are encountered during remedial operations, work will be stopped and the SHPO will be consulted. Through these actions, Alternative ST12-3 would comply with the archaeological ARAR.

The action-specific ARAR concerning air emissions during remediation is an applicable requirement. This requirement will be met through the application of fume incineration to soil gas extracted by the SVE system. The fume incinerator would be designed, operated, and maintained to ensure compliance with this ARAR.

The action-specific ARAR concerning the treatment of extracted soil moisture will be met by containerizing the water in a 55-gallon drum or a tote tank for subsequent transport to and treatment by the ST-12 groundwater treatment system. Currently, the treated groundwater at ST-12 is discharged to the sanitary sewer and must comply with pretreatment limits in the Base's permit with the local POTW. In the future, the treated water may be reinjected at ST-12. At that time, the treated water would have to comply with reinjection standards.

6.4 Alternative FT02-5: Bioventing

6.4.1 Source Treatment Component

This alternative would deliver oxygen to contaminated unsaturated deep soils by forced air movement to stimulate aerobic metabolism of fuel hydrocarbons by indigenous soil microorganisms. Depending on site characteristics, bioventing systems can be designed to supply oxygen to the subsurface by blowing air into the soil under positive pressure, extracting air from the soil under vacuum, or a combination of both. The preferred method is typically to supply air to the subsurface under positive pressure. This mode of operation eliminates point source air emissions that may require air pollution controls. A bioventing system would supply air to the subsurface using a blower (positive pressure) or exhauster (vacuum), piping system, and a network of air injection or extraction wells screened in the deep contaminated soils. Air would be supplied to the soil at rates that would provide sufficient oxygen to stimulate biodegradation while minimizing volatilization and release of contaminants to the atmosphere. As a result, bioventing systems typically operate at 10 to 30 percent of the air flow requirement for an SVE system in the same application. The bioventing system would also include the installation of a number of narrowly screened soil gas monitoring points to sample gas in short vertical sections of the soil. These points are used to monitor local oxygen concentrations. A block flow diagram for a bioventing treatment system is presented in Figure 6-5.

The preliminary design is based on air extraction (using vacuum) rather than air injection (using positive pressure) because the contaminated soil is deep and spread over a relatively wide area. Air injected into the formation would have to displace resident soil gas and push it to the surface. The injected air must be supplied at a pressure sufficient to overcome the resistance to flow presented by the torturous path the displaced soil gas must travel from the

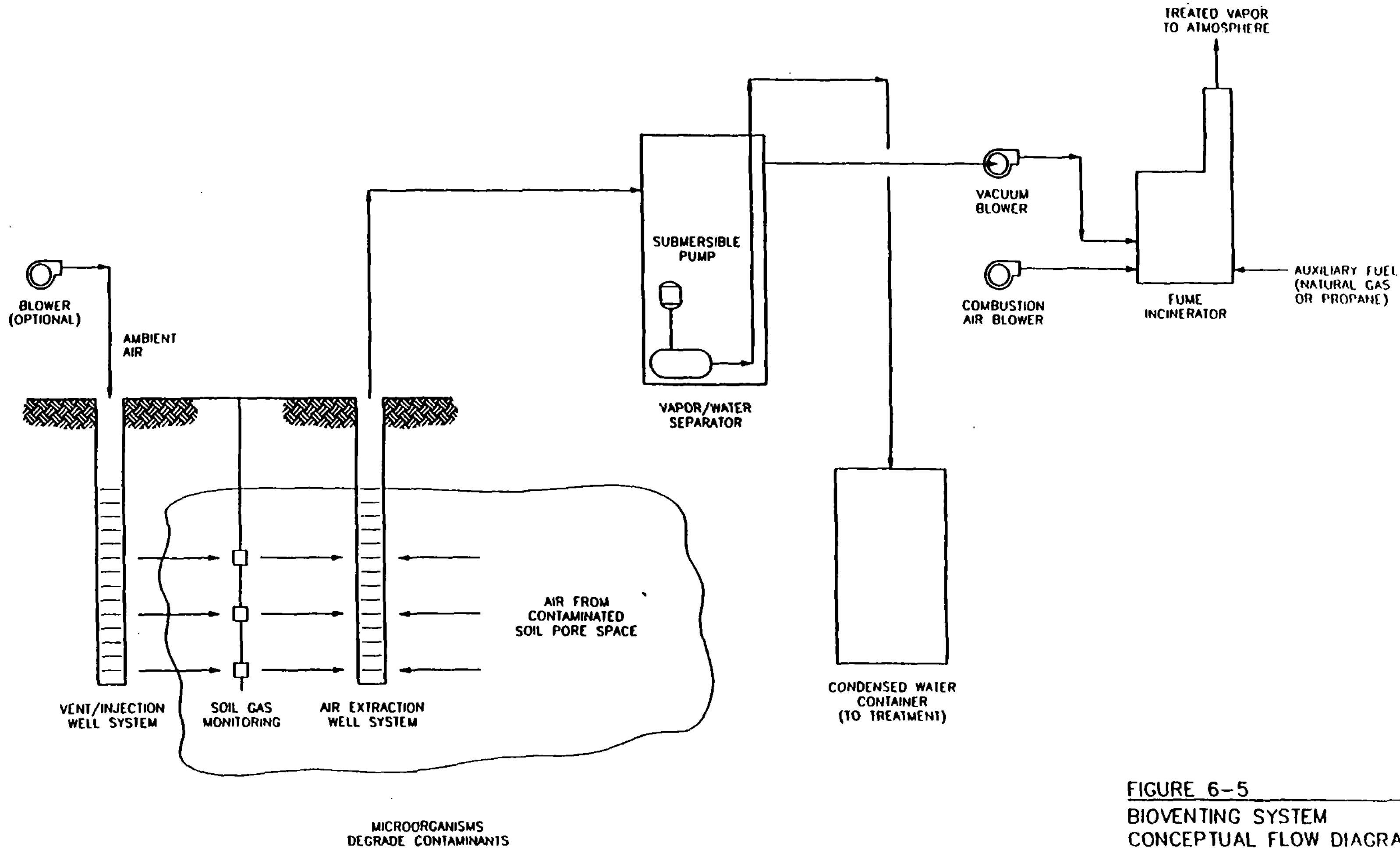


FIGURE 6-5
BIOVENTING SYSTEM
CONCEPTUAL FLOW DIAGRAM
LIQUID FUELS STORAGE AREA (ST-12)
DEEP SOIL AT OU-2
WILLIAMS AFB

INTERNATIONAL
TECHNOLOGY
CORPORATION

injection point through the upper soils to the surface. The resistance to flow increases as air is supplied deeper into the subsurface and the air flow path to the surface becomes longer. The resistance to flow is also affected by the soil type, as fine grain soils present more resistance to flow. Other bioventing design configurations (e.g., air injection) are possible, but a system designed to operate in an air injection mode would probably require more powerful blowers and additional wells. No attempt has been made during this stage of preliminary design to optimize the design of the treatment system, and the most effective mode of operation will be determined after field treatability studies and pilot tests are completed.

If site conditions are favorable for the implementation of bioventing, this alternative should reduce the concentrations of benzene and TPH in deep soil to respective PRGs of 5 and 2,000 mg/kg. Based on the system configuration previously described, it is estimated that bioventing would require 26 years to reduce contaminant concentrations in the deep soil to PRGs.

6.4.2 Source Containment Component

The alternative does not incorporate a containment component that would restrict the migration of contaminants from soil to groundwater. A containment component is not required because the treatment component would effectively remediate the contaminated soil.

6.4.3 Groundwater Component

The remedial alternative does not incorporate a groundwater extraction and treatment component because groundwater contamination was addressed in the OU-2 ROD.

6.4.4 General Components

There are no major implementation concerns associated with the construction and operation of a bioventing system. The units operate with limited operator attention. Initial monitoring of ambient air, similar to that for FT-02 soils (OU-3), in the vicinity of the treated soil would be required to confirm compliance with Maricopa County air quality standards.

Short-term risks will be similar to those described in Section 6.3.4 for SVE.

No long-term management, monitoring, or periodic site reviews would be required after remedial activities are complete. Sampling and analysis of subsurface soil would be used to confirm that the alternative has met RAOs. It is unlikely that the alternative would not accomplish RAOs at the site once a field treatability test has been conducted to predict its effectiveness. However, if bioventing proved to be ineffective after implementation, a properly designed system could be convertible to an SVE system with some equipment replacements or modifications. Nevertheless, the OU-2 groundwater remediation system would remain in operation until RAOs are achieved for soil and groundwater at ST-12.

The initial capital cost of Alternative ST12-4 is $2.5 million. The annual O&M cost for this alternative includes $0.3 million per year for operation of the bioventing treatment system, and $0.4 million per year for operation of the OU-2 groundwater remediation system. This results in a total O&M cost of $0.7 million per year, with details provided in Appendix A.

6.4.5 Compliance with ARARs

The ARARs appropriate for this alternative are presented in Appendix B.

6.5 Alternative ST12-5: Synergistic Alternative, SVE, Bioventing, and Natural Attenuation

6.5.1 Source Treatment Component

Alternative ST12-5 is a synergistic combination of the technologies in Alternatives ST12-2, -3, and -4 applied in a targeted and phased approach. This alternative is postulated to accomplish remediation goals in the most cost-effective manner by combining the best attributes of the previous three alternatives. SVE would be applied in areas with the highest contamination where significant migration of contaminants to groundwater could occur if remediation goals were not accomplished in a timely manner. Bioventing would be applied in areas where the impact of contaminant migration to groundwater is not a significant short-term threat, such as areas of more moderate contamination, or areas in the upper zone of the deep soil. Soil in areas where the concentration of contaminants represent no significant long-term migration threat to groundwater would be allowed to naturally attenuate. Alternatively, these individual process options could be applied in a sequential approach in some areas. For example, SVE could be applied to heavily contaminated soil to quickly remove the volatile components, and the system could be reconfigured for bioventing to remediate the semivolatile components of JP-4 that are not as easy to remove with SVE. Also, soil that have been partially remediated by SVE or bioventing such that the threat of contaminant migration to groundwater has been significantly reduced may be allowed to naturally attenuate.

This alternative should reduce the concentration of contaminants in the deep soil at the ST-12 site to levels below the PRGs.

6.5.2 Source Containment Component

The alternative does not incorporate a containment component that would restrict the migration of contaminants from soil to groundwater. A containment component is not required because the treatment component would effectively remediate the contaminated soil.

6.5.3 Groundwater Component

The remedial alternative does not incorporate a groundwater extraction and treatment component because groundwater was addressed in the OU-2 ROD.

6.5.4 General Components

Periodic soil gas monitoring and in situ respiration tests would be required for the SVE/bio-venting systems to assess the effectiveness of operation and determine set points for operating parameters. Sampling and analysis of subsurface soil would be used to confirm that the alternative has met PRGs. The OU-2 groundwater remediation system would remain in operation until RAOs are achieved for soil and groundwater at ST-12.

Short-term risks will be similar to those described for the SVE alternative in Section 6.3.4.

It is estimated that Alternative ST12-5 would achieve the RAOs for the site within approximately 9 years.

The initial capital cost of Alternative ST12-5 is $2.8 million. The annual O&M cost for this alternative includes $0.4 million per year for operation of the SVE/bioventing treatment system, and $0.4 million per year for operation of the OU-2 groundwater remediation system. This results in a total O&M cost of $0.8 million per year. Detailed annual O&M costs are presented in Appendix A.

6.5.5 Compliance with ARARs

The ARARs appropriate for this alternative are presented in Appendix B.

Compliance with location- and action-specific ARARs is achieved in the manner presented for Alternatives ST12-3 and ST12-4.

7.0 Comparative Analysis of Alternatives

The final phase in the evaluation of remedial alternatives for deep soil at ST-12 involves a comparison of various alternatives. The advantages and disadvantages of each alternative are reviewed relative to each of the nine EPA evaluation criteria used in the previous detailed analyses. For each criterion, the apparent best alternative is identified first, with the other alternatives presented in order relative to this alternative.

7.1 Overall Protection of Human Health and the Environment

All of the alternatives are determined to be protective of human health for the following reasons:

- No direct pathway exists for potential receptors to be exposed to contaminated deep soil.
- The OU-2 groundwater remediation system intercepts and treats contaminants migrating from deep soil into groundwater such that they will not present an acceptable human health risk at the OU-2 compliance point.
- Institutional controls have been implemented as a component of the OU-2 selected remedy to prevent excavation in ST-12 soil greater than 10 feet below ground surface and construction of a drinking water well in the contaminated aquifer underneath ST-12.
- Groundwater downgradient of the contaminated deep soil is periodically monitored to ensure the OU-2 groundwater remediation system is adequately protective of human health.

Alternative ST12-3 would be most protective of the environment because it would remediate deep soil contaminants to PRGs in the shortest duration (8 years). Alternative ST12-5 would protect the environment by reducing soil contaminants to PRGs in approximately 9 years. Alternative ST12-4 would protect the environment by reducing soil contaminants to PRGs over an estimated 26 years. Alternative ST12-2 would be less protective of the environment than any of the active remedial measures. Because no reliable data exists on natural attenuation of JP-4 in soil, it is difficult to predict its effectiveness. Significant migration of JP-4 to groundwater could occur from highly contaminated zones before natural biodegradation process would reduce soil contaminants to concentrations that would be protective of the environment. However, the long-term monitoring associated with Alternative ST12-2 would permit periodic reassessments to determine if the progress of natural attenuation is consistent with RAOs. In the absence of any natural biodegradation in the deep soil, it is estimated that 30 years would be required before sufficient contaminants have migrated from soil such that further migration would be limited in nature and consistent with RAOs. It may be noted that the modeling efforts to determine compliance in groundwater (Appendix F, OU-3 FS) assumed that a groundwater pump and treat system for OU-2, working in conjunction with natural attenuation in groundwater, would result in compliance. This model also assumed that contamination in deep soil would not be remediated or attenuated naturally and would be leaching to groundwater. Thus, the modeling effort used natural attenuation in conjunction with the groundwater treatment system and yielded a 30-year estimate for OU-2 to be in compliance. Alternative ST12-1 would not be protective of the environment because no active RAs would be implemented, and no monitoring would be conducted to evaluate the progress of natural attenuation or determine the environmental impact of contaminant migration.

7.2 Compliance with ARARs

No chemical-specific ARARs exist for COPCs in soil. ARARs for alternatives ST12-2 through ST12-5 are presented in Appendix B. ARARs are not applicable for Alternative ST12-1. Alternatives ST12-2 through ST12-5 would meet all applicable action- and location-specific ARARs.

7.3 Long-Term Effectiveness and Permanence

Alternatives ST12-3 through ST12-5 present approximately equivalent measures of long-term effectiveness and permanence by permanently reducing soil contaminants to PRGs, which would prevent the future migration of contaminants to groundwater at levels that would not be protective of human health at the OU-2 groundwater compliance point. Alternative ST12-2 should eventually reduce contaminants to PRGs, but it is not clear that the majority of this reduction would occur as a result of natural biodegradation. Migration to groundwater might be the dominant natural attenuation process. However, the operation of the OU-2 groundwater remediation system would mitigate the impact of deep soil contaminants on groundwater. Alternative ST12-1 does not achieve long-term effectiveness or permanence because the alternative does not incorporate a monitoring component that would confirm eventual compliance with RAOs. As with Alternative ST12-2, the dominant natural attenuation process may be migration of contaminants to groundwater.

7.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives ST12-3 through ST12-5 would provide approximately equivalent degrees of toxicity reduction, because all are capable of reducing contaminant levels to PRGs and of effecting irreversible destruction of contaminants. By reducing the concentration of TPH in soil to PRGs, Alternatives ST12-3 through ST12-5 also eliminate further migration of free-phase JP-4. These three alternatives satisfy the statutory preference for treatment. Alternatives ST12-1 and ST12-2 do not actively remediate soil and, therefore, do not satisfy the statutory preference for treatment. These alternatives may eventually reduce the level of JP-4 in soil to PRGs through natural attenuation. However, it is not clear that a significant degree of toxicity reduction would be involved, because migration to groundwater may be the dominant natural attenuation process. For all alternatives, migration of contaminants to groundwater during the remediation process would be mitigated by the operation of the OU-2 groundwater remediation system (IT, 1992b).

7.5 Short-Term Effectiveness

Alternative ST12-3 is the most effective in the short term because it would achieve RAOs in the shortest duration and minimize the environmental impact of JP-4 migration to groundwater. Alternative ST12-5 would be effective by meeting RAOs in approximately 9 years. Alternative ST12-4 would also be effective during the remedial period, but because this alternative would take longer to reach PRGs, a larger mass of JP-4 could potentially migrate to groundwater in comparison to Alternatives ST12-3 and ST12-5. Alternatives ST12-1 and ST12-2 would be the least effective over the short term. Even though these alternatives present slightly less risk to the community or site workers than Alternatives ST12-3 through ST12-5, no active effort would be made to prevent the migration of JP-4 to groundwater. This could result in an extension of institutional actions and RAs at ST-12 implemented under the OU-2 ROD (IT, 1992b).

A significant uncertainty is associated with the estimates of remedial duration for all of the alternatives. In terms of relative uncertainty, the estimate for ST12-3 is probably the most reliable, with correspondingly increasing degrees of uncertainty associated with Alternatives ST12-5, ST12-4, and ST12-2.

7.6 Implementability

Alternative ST12-1 is the easiest to implement because no action is taken. Alternative ST12-2 is also relatively easy to implement because only long-term monitoring is required. Alternatives ST12-3 through ST12-5 are relatively equivalent in terms of implementability.

7.7 Cost

Table A-1, Appendix A summarizes the estimated capital, O&M, and present worth cost for each of the five remedial alternatives. Alternative ST12-5 has the lowest net present value of any alternative ($9.6 million). It has the highest initial capital cost, but the overall net present value is low due to its relatively short remedial duration. Alternative ST12-3 has the second lowest net present value ($9.9 million). Although this alternative has the second highest initial capital cost, its overall net present value is low because it has the shortest remedial duration. Alternative ST12-1 has a net present value of $10.3 million. There are no initial capital costs associated with this alternative, but it has a remedial duration estimated to be 30 years. Alternative ST12-2 has a net present value of $14.7 million. The initial capital costs are low, but the estimated 30-year remedial duration inflates the net present value. Alternative ST12-4 has the highest net present value of all the remedial alternatives ($18.4 million). It has the lowest initial capital cost of the active remedial alternatives, but has an estimated remedial duration that is more than double that of Alternative ST12-3.

The difference in net present value between the alternatives are all within the margin of error of the cost estimates. In particular, the cost estimates are very sensitive to the estimated period of RA. The RA duration of each alternative has been estimated using best engineering judgement. However, additional engineering data would be required to refine the RA duration for each alternative. The RA duration of several of the alternatives is heavily dependent on the rate of biodegradation in soil and/or groundwater. Therefore, it is recommended that an SVE, bioventing, and natural attenuation treatability study be conducted to optimize the location and volume of soil to which each technology should be applied. The final decision on the preferred remedy can then be based on these results.

7.8 Support Agency Acceptance

The various remedial alternatives will be evaluated after comments from state support agencies and the public have been received on the OU-2 proposed plan amendment.

7.9 Community Acceptance

The various remedial alternatives will be evaluated after public comment has been received on the OU-2 proposed plan amendment.

8.0 Selected Remedy

The selected remedy for the deep soil at ST-12 is Alternative ST12-5: synergistical alternative, SVE, bioventing, and natural attenuation. The specific components of this alternative were presented in summary form in Section 6.5 and are fully described in this section.

Alternative ST12-5 satisfies the two threshold criteria, overall protection of human health and the environment and compliance with ARARs, and provides the best balance of the nine criteria presented in Figure 6-3. The selected remedy will provide the greatest level of effectiveness that is technically and economically feasible. The criterion of protection of human health and the environment is appropriately balanced with both effectiveness and technical/economic feasibility.

8.1 Major Components of the Selected Remedy

Alternative ST12-5 is a synergistic combination of Alternatives ST12-2, ST12-3, and ST12-4. This alternative endeavors to accomplish remediation goals in the most cost-effective manner by combining the best attributes of the SVE, bioventing, and natural attenuation remedial alternatives. SVE would be applied in areas with the highest contamination where significant migration of contaminants to groundwater could occur if cleanup goals were not accomplished in a timely manner. Bioventing could be applied in areas where the impact of contaminant migration to groundwater is not a significant short-term threat, such as areas of more moderate contamination, or areas in the upper zone of the deep soil. Soil in areas where the concentration of contaminants represent only a limited long-term migration threat to groundwater could be allowed to naturally attenuate. Alternatively, these individual process options could be applied in a sequential approach in some or all areas. For example, SVE could be applied to heavily contaminated soil to quickly remove the volatile components, and the system could be reconfigured for bioventing to remediate the semivolatile components of JP-4 that are not as amenable to treatment via SVE. Also, soil that has been partially remediated by SVE or bioventing such that the threat of contaminant migration to groundwater has been significantly reduced may be allowed to naturally attenuate. The proper mix of these three process options would be defined after the appropriate treatability studies are completed to determine the relative effectiveness of each remedial component.

Field treatability studies are recommended to better predict the effectiveness of SVE, bioventing, and natural attenuation with respect to site-specific conditions, and determine the staging points at which each technology should be implemented. After these field treatability studies are completed, the proper staging of each of these remedial technologies can be made at various areas of the site to maximize their effectiveness.

An SVE field treatability test is recommended to confirm the effectiveness of this remedial technology and determine important design parameters such as soil gas permeability and the organic composition of soil gas. These values would be used to size the vacuum exhauster system and the fume incinerator. The soil gas flow rate and initial gas composition would also be used to calibrate an SVE model to predict the duration of this component of the overall RA.

A bioventing field treatability test is recommended to determine that site conditions such as soil moisture, pH, permeability, oxygen utilization, and nutrients are adequate to support its implementation. The results of this testing would be used in predictive models to determine those areas where bioventing could be appropriately applied such that RAOs are cost-effectively achieved. The results of the bioventing tests would also be used to determine its effectiveness and predict the duration of this component of the overall RA.

A natural attenuation treatability study is recommended to estimate the rate at which natural biodegradation processes remove COCs from soil and groundwater. The results of these tests will be used in conjunction with predictive transport models to determine natural attenuation effectiveness and identify those areas where it can be appropriately applied such that RAOs are cost-effectively achieved. Because an assumed biodegradation factor in groundwater was used in the calculation of cleanup levels for deep soil, the results of natural attenuation studies for groundwater will also be used to confirm the protectiveness of these cleanup levels based on the biodecay factor.

Because the deep soil at ST-12 presents no direct threat to human health via exposure to contaminated soil, the objectives of conducting RAs are to reduce the time required to effect groundwater cleanup and to remove sources of JP-4 that may continue to impact groundwater, thereby minimizing the cost of remediating the entire site. The cleanup levels for deep soil were determined through a computer modeling approach used to estimate the migration rate of chemicals from ST-12 deep soil to groundwater. Vadose zone and groundwater transport models were used to calculate the soil concentrations for individual compounds that would not result in groundwater concentrations at the compliance point in excess of cleanup levels, and the TPH concentration at which the residual deep soil contamination would no longer

represent a viable source of contamination to groundwater. The ST-12 groundwater compliance point is to be determined in the future based upon the mutual agreement of the parties to the FFA. The selected remedy will be implemented in the deep soil until the cleanup level of 5 mg/kg benzene has been attained. In addition, the JP-4 contamination in the deep soil, measured as TPH, will be reduced to a concentration of 2,000 mg/kg. These cleanup levels are to be considered as target concentrations that are subject to change. Enforceable cleanup levels will be established by the Parties to the FFA after additional post-ROD information is collected, such as natural attenuation treatability data for soil and groundwater, performance data for the ST-12 groundwater extraction system, SVE and bioventing pilot test data, and other pertinent field data (e.g., groundwater elevation data).
Approximately 422,000 cubic yards of contaminated soil requires RA to achieve the RAOs for the deep soil. It was estimated during the OU-3 FS that the successful remediation of the deep soil will result in the volatilization and thermal destruction or biodegradation of approximately 21,400 kg of benzene and 1.9 million kg of TPH.

In the absence of site-specific treatability data for SVE and bioventing in the deep soil, a computer model approach was used during the OU-3 FS to estimate the parameters (i.e., vacuum and air flow) required to develop a preliminary treatment system design and predict the duration of RA. It was estimated that 33 air extraction/injection wells would be constructed at ST-12 based on the projected area and depth of soil requiring remediation. The final number of wells will be based on the results of soil and groundwater treatability studies, with the concurrence of the Parties to the FFA. The numbers and costs stated herein could therefore change. A preliminary air extraction/injection well layout is presented in Figure 6-4. The extraction wells were assumed to be 4 inches in diameter, screened over a 35-foot interval, with a 40-foot radius of influence. The treatment system would be sized to operate initially as an SVE system at a total air flow rate of 2,000 scfm at 15 inches of mercury vacuum. The system would be constructed to be convertible to a bioventing system operating at approximately 600 scfm. In estimating the remedial duration required to achieve RAOs, it was assumed that the treatment system would operate in an SVE mode for the first 2 years of operation, and then in a bioventing mode for approximately 7 more years. At the end of this period, the remaining deep soil contamination would be allowed to naturally attenuate.

A fume incinerator will be required to control emissions from the SVE system. Based upon the results of the computer model used to predict the concentration of organic compounds in extracted soil gas, it is estimated that the fume incinerator would be sized for 3,000 scfm of air flow, and a heat duty of 10 million British thermal unit (Btu) at 1400°F. The concentration of VOCs in the exhaust duct from the fume incinerator will be monitored at start-up to confirm that the system is in compliance with Maricopa County Air Pollution Control Division requirements.

Operation of the fume incinerator may not be required during bioventing, depending on the final design and operating configuration of the bioventing system. Bioventing systems that are operated in an air injection configuration do not typically require emission controls because the potential for volatile emissions is very low. Bioventing systems are characterized by a low rate of air injection. Because the horizontal permeabilities of the ST-12 deep soil is typically greater than the corresponding vertical permeabilities, and the most highly contaminated soil are at significant depths, the injected air will tend to move outward rather than upward. This will promote in situ biodegradation of organic vapors as they move slowly outward from the air injection zone. To ensure compliance with Maricopa County Air Pollution Control Division requirements, a surface emission monitoring program will be initiated following start-up of the bioventing phase of the RA.

Soil and soil gas monitoring will be conducted periodically during the operation of the treatment system to evaluate the effectiveness of the RA and determine when cleanup levels have been met. The details of the monitoring program will be determined during the RD/RA process.

No institutional or engineering controls will be required for the deep soil after the remedy has achieved cleanup goals.

Because field treatability tests have not yet been performed to evaluate the relative effectiveness of each treatment component, some changes may be made to the design of the selected remedy as presented here after additional information is gathered. In general, these changes reflect modifications to the remedy resulting from the engineering design process. The size and configuration of the treatment system components will be finalized during RD after all field treatability tests have been completed.

8.2 Cost

The initial capital cost of the selected remedy is $2.8 million. As shown in Appendix A, Table A-9, this includes the cost of the SVE, bioventing, and natural attenuation treatability tests; SVE and bioventing treatment system design, construction, and start-up; and the monitoring required to document the effectiveness of natural attenuation processes.

The annual O&M cost for the selected remedy includes $0.4 million per year for operation of the SVE/bioventing treatment system, and $0.4 million per year for operation of the OU-2 groundwater remediation system. This results in a total O&M cost of $0.8 million per year. Detailed annual O&M costs are presented in Appendix A, Table A-10 and A-11.

The net present worth of the selected remedy includes $6.4 million for capital and O&M costs associated with construction and operation of the SVE/bioventing system, and $3.2 million for the operation of the OU-2 groundwater remediation system for the estimated 9 years required to meet cleanup goals. This results in a total net present worth for the selected remedy of $9.6 million.

9.0 Statutory Determinations

Under Section 121 of CERCLA, the selected remedy must be protective of human health and the environment and must comply with all ARARs. The selected remedy also must be cost-effective and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. Remedies that employ treatment options that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as a major part of the remedy are preferable. This chapter discusses how the selected remedy meets these requirements.

The State of Arizona and the communities surrounding Williams AFB were involved in the determination of the selected remedy. The state was represented in the process by ADEQ and Arizona Department of Water Resources (ADWR), both of whom are parties to the FFA. They have been intrinsically involved in the review and approval of all documents and decisions concerning the various stages of the remedial process, including all work plans, RI/FS reports, proposed plans, and RODs.

The communities surrounding Williams AFB have been involved in the decision-making process through the Technical Review Committee, the Restoration Advisory Board, and through public meetings and comment periods on proposed remedies and removal actions. Chapter 11.0 of this document addresses the communities' involvement in more depth.

Alternative ST12-5 (synergistic alternative, SVE, bioventing, and natural attenuation) was the selected remedy. The selected remedy represents the best balance among alternatives with respect to the pertinent criteria, given the scope of this action.

9.1 Protection of Human Health and the Environment

The deep soil at ST-12 presents no direct threat to human health because the soil are a minimum of 25 feet below ground surface; therefore, there are no complete exposure pathways to the contaminated soil. The groundwater beneath ST-12 soil is contaminated with JP-4 constituents. A free-phase layer of JP-4 is floating on top of the groundwater. Vadose zone transport modeling performed during the OU-3 RI predicted that the contaminants from JP-4 in the deep soil would continue to migrate to groundwater for many years if no action was taken to remediate the deep soil. Although the deep soil contamination presents no direct threat to human health, the implementation of the selected remedy would minimize the future impact of deep soil contamination on groundwater by removing organic contaminants through in situ biodegradation and/or soil gas extraction followed by thermal destruction.

9.2 Compliance with ARARs

The selected remedy of SVE, bioventing, and natural attenuation will comply with all chemical-, action-, and location-specific ARARs. A discussion of the pertinent ARARs follows.

9.2.1 Chemical-Specific ARARs

No statutory limits have been promulgated by state or federal regulatory authorities for organic contaminants in soil. Therefore, chemical-specific ARARs do not exist for soil.

9.2.2 Location-Specific ARARs

The ARAR concerning the protection of significant archaeological artifacts is a relevant and appropriate requirement. Prior to the initiation of any remedial activities at the site, remedial plans will be reviewed with the SHPO to obtain his approval. If any obvious archaeological artifacts are encountered during remedial operations, work will be stopped and the SHPO will be consulted. Through these actions, the selected remedy would comply with the archaeological ARAR.

9.2.3 Action-Specific ARARs

The ARAR concerning air emissions during remediation is an applicable requirement. The Maricopa County Air Pollution Control Division places a 3-pound-per-day limit on uncontrolled VOC emissions during remedial operations. This requirement will be met during operation of the SVE treatment system by thermally destroying organic contaminants in extracted soil gas via fume incineration. The fume incinerator will be designed, tested, operated, and maintained to ensure compliance with this limit. It is anticipated that the operation of the bioventing system will not require emission controls because soil gas is typically not extracted from the subsurface. However, a surface emission monitoring program will be initiated following start-up of the bioventing system to ensure compliance with the VOC limit.

The ARAR concerning surface water control is considered an appropriate requirement. The selected remedy will meet this requirement by providing storm water collection in areas where soil cuttings are stored.

The ARAR concerning on-site container storage is an applicable requirement. The selected remedy will comply with the requirements of RCRA Section 40 CFR 264 concerning the handing, inspection, and maintenance issues associated with the storage of soil cuttings.

The ARAR concerning the treatment of extracted soil moisture will be met during operation of the SVE system by containerizing the water in a 55-gallon drum or a tote tank for subsequent transport to and treatment by the ST-12 groundwater treatment system. Treated groundwater at ST-12 has been discharged to the sanitary sewer and complied with pretreatment limits in the Base's permit with the local POTW. In the future, the treated water may be reinjected at ST-12. However, based on results of field treatability studies and natural attenuation testing, either groundwater withdrawal may not be required or if required, treated water could be discharged to the sanitary sewer or reinjected. At the time, a decision is made, any treated water would comply with reinjection standards. Because bioventing systems do not typically extract vapors from the subsurface, water collection and treatment equipment would not be necessary during this mode of operation.

9.3 Cost Effectiveness

The selected remedy was evaluated for cost effectiveness against the other four potential remedial alternatives that were subjected to a detailed analysis in the OU-3 FS report. The selected remedy has the lowest net present value of all the alternatives when its impact on the duration of groundwater remediation is factored into the cost analysis. Because the selected remedy has the potential to minimize the duration of groundwater remediation, its implementation as a component of the overall RA at ST-12 should result in reducing the total cost to clean up the site.

The methodology used to calculate the comparative costs of the various remedial alternatives is based on a number of assumptions that may be validated with data collected during future field treatability studies and pilot tests. Because the type of RA selected for the deep soil will potentially affect the duration and cost of groundwater remediation at the site, the annual O&M cost for the groundwater extraction and treatment system has been included in the net present value of each deep soil alternative. This is based on the premise that the existing groundwater contamination will be reduced to cleanup levels within the period required to meet cleanup levels for COCs in the deep soil. Groundwater extraction and treatment system effectiveness in removing the free- and dissolved-phase organic contaminants from the aquifer within the RA period for deep soil is necessary for the premise to be valid. Because the net present value of several of the alternatives are within a narrow range, any significant change in the basis used to calculate the costs could result in a different alternative being selected as the most cost-effective remedy. As shown in Appendix A, Table A-1, there is only a 7.5 percent difference in the net present value of the selected remedy and the no-action alternative. Information to be collected during SVE, bioventing, and natural attenuation field treatability studies and the pilot/demonstration study for the groundwater extraction and treatment system will permit a more accurate prediction of the cost of total site remediation under various deep soil remedial alternatives.

9.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Possible

The selected remedy (SVE, bioventing, and natural attenuation) utilizes permanent solutions and treatment technologies to the maximum extent practicable. It is the remedial alternative that represents the optimum balance among the alternatives with respect to the nine EPA evaluation criteria, especially the balancing criteria of short-term effectiveness, implementability, and cost.

The selected remedy achieves the same degree of long-term effectiveness and permanence as SVE or bioventing because all these alternatives involve treatment that will achieve cleanup levels for the deep soil. The no-action and natural attenuation alternatives provide no measure of short-term effectiveness because any natural reduction in contaminant concentrations would occur only over a long period of time. The selected remedy and the SVE and bioventing alternatives will also achieve essentially equivalent reductions in the toxicity, mobility, and volume of contaminated soil because all three alternatives would achieve cleanup levels. The no-action and natural attenuation alternatives would achieve only limited reductions in toxicity, mobility, and volume of contaminated soil. The selected remedy and the SVE alternative would achieve similar measures of short-term effectiveness because they are currently projected to meet cleanup objectives within approximately 8 to 9 years. Bioventing would be much less effective over the short term because it is predicted to require 26 years to meet cleanup levels. The no-action and natural attenuation alternatives would not be effective in the short term. The implementability of the selected remedy is essentially equivalent to the implementability of either the SVE or bioventing treatment alternatives because these two treatment technologies use the same components as the selected remedy. The selected remedy has the lowest net present value of all the alternatives, because it will optimize the contaminant reduction with a given technology and, therefore, be the most cost effective.

The ADEQ and ADWR were involved at each step in the remedy selection process for OU-3, reviewing and approving the engineering evaluation/cost analysis, RI/FS, proposed plan, proposed plan fact sheet, and the ROD. The specific actions that implement the RODA will be included in the RD/RA documents, which will be in accordance with the FFA and will be coordinated with ADEQ, ADWR, and EPA.

9.5 Preference for Treatment as a Principal Element

The ADEQ and ADWR were involved at each step in the remedy selection process for the OU-2 amendment and OU-3 under which operable unit the deep soil had been investigated, reviewing and approving the RI/FS, proposed plan, proposed plan fact sheet, and the ROD.

The public was invited to offer comment at each step in the process through public comment periods advertised in local newspapers and at a public meeting. A fact sheet providing a condensed version of the remedy selection process contained in the proposed plan was distributed to the media along with a news release and to those who attended the public meeting. In addition, the proposed plan and the proposed plan fact sheet were placed in the information repository located at the Gilbert Public Library. The RAB was briefed on the selected remedy for the Deep Soil in the OU-2 amendment.

10.0 Documentation of Significant Changes

There have been no significant changes on the OU-2 as a result of the public meeting held on February 21, 1996.

11.0 Responsiveness Summary

This section documents that no public comments were received after the issuance of the proposed plan, therefore; there were no USAF responses required. There were comments received during the public meeting regarding the extent of the plume. The questions and answers are shown below:

- Delores Spidel who lives on 185th Street, right by Ray Road, where Ray Road dead-ends, asked about the plume. Dr. Harris indicated the direction of groundwater flow was east. Mr. Carter added that groundwater flows east but has a component that swings north and moves toward the northern boundary of the Base. Richard Freitas had no comment.

- Len Fuchs then asked Ms. Spidel if she felt secure living next to Williams AFB. Delores Spidle said that she did, but that she wanted to move and wanted somebody to buy the property.

- Richard Freitas mentioned that the record of decision will be issued after the proposed plan.

- Dr. Harris said that the OU-2 record of decision amendment, which is the official document that says what technology will be used for a remedial alternative, will be issued after the treatability study is complete and the Air Force has demonstrated that the new technologies being proposed will work.

12.0 References

Arizona Department of Environmental Quality (ADEQ), 1990, LUST Site Characterization Report Checklist.

Howard, P. H., R. S. Boethling, W. F. Jarvis, W. M. Meylan, and E. M. Michalenko, 1991, ***Handbook of Environmental Degradation Rates***, Lewis Publishers, Inc., Chelsea, Michigan.

IT Corporation, 1995, ***Final Feasibility Study Report, Operable Unit 3***, prepared for Air Force Base Conversion Agency, Williams Air Force Base, Arizona, May 1995.

IT Corporation, 1994, ***Final Remedial Investigation Report, Operable Unit 3***, prepared for Air Force Base Conversion Agency, Williams Air Force Base, Arizona, September 1994.

IT Corporation, 1993a, ***Final Work Plan Addendum, Operable Unit 3***, prepared for the USAF Air Training Command, Randolph Air Force Base, Texas, August 1993.

IT Corporation, 1993b, ***Field Sampling Plan Addendum, Operable Unit 3***, prepared for the USAF Air Training Command, Randolph Air Force Base, Texas, August 1993.

IT Corporation, 1992a, ***Final Remedial Investigation Report, Liquid Fuels Storage Area - Operable Unit 2, Williams Air Force Base***, prepared for the USAF Air Training Command, Randolph Air Force Base, Texas, January 1992.

IT Corporation, 1992b, ***Final Record of Decision Report, Operable Unit 2***, prepared for the USAF Air Training Command, Randolph Air Force Base, Texas, December 1992.

IT Corporation, 1992c, ***Final Feasibility Study Report, Operable Unit 2***, prepared for the USAF Air Training Command, Randolph Air Force Base, Texas, April 1992.

U.S. Environmental Protection Agency (EPA), 1989, ***Interim Final Guidance on Preparing Superfund Decision Documents***, Office of Emergency and Remedial Response, Washington DC, November, 9355.3-02.

APPENDIX A

COST

TABLE A-1. COST SUMMARY FOR ST-12 DEEP SOIL ALTERNATIVES

Williams AFB
Project-409877.010
KT - wiu3suw2 - 04/07/95

COST COMPONENT	TABLE E.2-2 NO ACTION ST12-1 NO MONITORING	TABLES E.2-3,2-4 NATURAL ATTENUATION ST12-2 BIODEGRADATION MONITORING	TABLES E.2-5,2-6 SOIL VAPOR EXTRACTION (SVE) ST12-3 FUME INCINERATION (FI)	TABLES E.2-7,2-8 BIOVENTING FI ST12-4	TABLES E.2-9,10,11 SVE, BIOVENTING, AND NATURAL ATTENUATION, FI ST12-5
INSTALLED CAPITAL COST (A)	$0	$234,900	$2,637,100	$2,456,600	$2,812,100
REMEDIATION TIME (YEARS) (a)	30	30	8	26	9
ANNUAL SOIL O&M (First & Second Year)	$28,000	$195,700	$599,200	$338,600	$599,200
ANNUAL SOIL O&M (Third Year and later)					$388,700
ANNUAL GROUNDWATER O & M	$385,500	$385,500	$385,500	$385,500	$385,500
O & M SUBTOTAL COST ($/YEAR)	$413,500	$581,200	$984,700	$724,100	$774,200
NET PRESENT VALUE COST (B) (b)					
SOIL OPERATING AND MAINTENANCE	$698,700	$4,883,700	$4,416,000	$7,458,300	$3,606,600
GROUNDWATER O&M	$9,620,200	$9,620,200	$2,841,100	$8,491,400	$3,181,200
TOTAL NET PRESENT VALUE (A+B)	$10,318,900	$14,738,800	$9,894,200	$18,406,300	$9,599,900

INFLATION	4%
INTEREST	5%

a. Remediation time for free product layer will be the same for any remediation alternative.

b. Net Present Values for the remediation alternatives are based on 4% inflation, and 5% interest rate.

TABLE A-2. NO ACTION FOR ST-12 DEEP SOILS
Annual Operation and Maintenance Costs

Williams AFB
Project-409877.010
KT - S1 - 03/29/95

COST COMPONENT	UNIT COST ($)	UNIT	QTY	UNITS/ PERIOD	ANNUAL COST ($)
1. Monitoring labor	50	hour (hr)	0	hr per sampling event	0
TOTAL OPERATING COST					0
1. Insurance, permits, taxes	4% operating				0
2. Rehabilitation costs					NA
3. Contingency	25% operating				0
4. Periodic site review (a)					28,000
TOTAL ANNUAL OPERATING COST (+50%, -30%)					28,000

a. Every 5 years, including groundwater modeling, cost shown is allocation for 1 year.
NA - Not applicable.

TABLE A-3. NATURAL ATTENUATION FOR ST-12 DEEP SOILS

Initial Capital Costs

Williams AFB
Project-409877.010
KT - S2 - 03/29/95

COST COMPONENT	DESCRIPTION	COST ($)
DIRECT CAPITAL COSTS		
1. Soil gas monitoring wells for natural biodegradation test		174,000
- A3 (Areas SB-5, 8, 10, 11)	2 wells, 215 ft deep, 10" diameter bore each has two 0.5" diameter vapor probe, 0.5 ft screen per probe	
- A34 (Areas SB-4, 6 , 7, 9A, 9B)	2 wells, 215 ft deep, 10" diameter bore, each has ten 0.5" diameter vapor probe, 0.5 ft screen per probe	
- A12 (Area SB-3)	1 well, 215 ft deep, 10" diameter bore, has three 0.5" diameter vapor probe, 0.5 ft screen per probe (one background sample will be included in sampling)	
2. Groundwater monitoring wells for natural biodegradation test	Existing monitoring wells (10) will be used	NI
TOTAL DIRECT COSTS (TDC)		174,000
INDIRECT CAPITAL COSTS		
1. Engineering and related tech support	8 % TDC	13,920
2. License, Permit, and Legal Fees	2 % TDC	3,480
3. Start-up	5 % TDC	NA
4. Contingency	25 % TDC	43,500
TOTAL INSTALLED COST (+50%, -30%)		234,900

NA - Not applicable.
NI - Not included.

TABLE A-4. NATURAL ATTENUATION FOR ST-12 DEEP SOILS

Annual Operation and Maintenance Costs

Williams AFB
Project-409877.010
KT - S2 - 03/29/95

COST COMPONENT	UNIT COST ($)	UNIT	QTY	UNITS/ PERIOD	ANNUAL COST ($)
1. Soil gas collection for biodegradation monitoring	100	sample	28	samples/6 months	5,600
2. Soil gas analyses for biodegradation monitoring	450	sample	28	samples/6 months	25,200
3. Soil Boring (a)	84,000	Sampling event	11	borings/5 years	16,800
4. Soil monitoring (VOC) (b)	10,000	Sampling event	1	sampling event/ 5 years	2,000
5. Soil Bio Monitoring (11 bores)	26,000	Sampling event	1	sampling event/ 5 years	5,200
6. Groundwater collection for biodegradation monitoring	7,000	Sampling event	1	sampling event/ 3 months	28,000
7. Groundwater monitoring	1,000	sample	7	samples/3 months	28,000
8. Groundwater data evaluation	100	hr	128	hours/year	12,800
9. Soil gas data evaluation	100	hr	64	hours/year	6,400
TOTAL OPERATING COST					130,000
1. Insurance, permits, taxes	4% operating				5,200
2. Rehabilitation costs					NA
3. Periodic site review (c)					28,000
4. Contingency	25% operating				32,500
TOTAL ANNUAL OPERATING COST (+50%, -30%)					195,700

a. Eleven borings with split spoon sampling.
b. Soil analysis includes a total of 25 samples.
c. Every 5 year, including groundwater modeling, cost shown is allocation for 1 year.
NA - Not applicable.

TABLE A-5. SVE FOR ST-12 DEEP SOILS
Initial Capital Costs

Williams AFB
Project-409877.010
KT - S3FI - 03/29/95

COST COMPONENT	DESCRIPTION	COST ($)
DIRECT CAPITAL COSTS		
1. Site Preparation	3 acres	10,000
2. Extraction Wells - A4 (Area SB-6, 7, 9A, 9B), and - A3 (Area SB-4, 5, 8, 10, 11). - A2 (SB-3)	All wells are 4" diameter 16 wells at 180 ft deep, and 16 wells at 215 ft deep, each has 35 ft screen 1 well at 215 ft deep, 35 ft screen	651,000
3. Passive vent wells	11 wells at 215 ft deep, 4" diameter	236,000
4. Demobilization of operating wells	After completion of the operation (44 wells)	143,000
5. Nested pieziometers	extraction well nearby will be used	0
6. Piping system and foundation (surface sealing is not included)	2,000 linear feet (4",6 "and 10" diameter) (underground construction cost is included)	183,000
7. SVE Vacuum Skid-Mounted Systems Two 1,000 scfm blowers	Including air/water separator & instrumentation 18" Hg vacuum, 200 hp motor each	218,000
8. Condensate transfer system (pump, tank and piping)	Condensate from 2 air/water separators will be pumped to the existing system	14,000
9. One Thermal Oxidation System with catalytic module (no heat exchanger)	Skid mounted system, rated for 3,000 scfm 10 million (MM) btu/hour, 1,400 ° F	191,000
10. Electrical equipment	Including installation, wiring, and telemanager monitoring system	52,000
11. Shipping	6% of items 7 and item 9 (approx)	24,500
TOTAL DIRECT COSTS (TDC)		1,722,500
INDIRECT CAPITAL COSTS		
1. Engineering and related tech support	15 % TDC	258,400
2. SVE Pilot Test	Air permeability and pressure test (well installation is not included)	105,000
3. License, Permit, and Legal Fees	2 % TDC	34,500
4. Start-up (sampling costs are included)	5 % TDC	86,100
5. Contingency	25 % TDC	430,600
TOTAL INSTALLED COST (+50%, -30%)		2,637,100

NA - Not applicable.

TABLE A-6. SVE FOR ST-12 DEEP SOILS
Annual Operation and Maintenance Costs

Williams AFB
Project-409877.010
KT - S3FI - 03/29/95

COST COMPONENT	UNIT COST ($)	UNIT	QTY	UNITS/ PERIOD	ANNUAL COST ($)
1. Operating labor (a)	50	hour (hr)	8	hours / week	20,800
2. Monitoring labor	50	hr	8	hours / month	4,800
3. Maintenance					10,000
4. Materials					NA
5. Utilities					
. Electric Power 2 Vacuum skids (400 Hp), gas fan, and water pumps.	0.08	Kwhr	8,146	Kwhr/day	237,900
. Fuel for fume incineration.	5.00	million btu	50.4	million btu/day	92,000
6. Disposal					NA
7. Purchased services:					
a) Vapor samples analyses (b)	400	sample	6	samples/month	28,800
b) Water samples analyses	350	sample	1	samples/month	4,200
c) Soil Boring (b) (c)	90,000	sampling event	9	borings/2 years	45,000
d) Soil Monitoring (VOC) (d)	10,000	sampling event	1	sampling event/ 2 years	5,000
8. Data evaluation	100	hr	40	hr/ 3 months	16,000
TOTAL OPERATING COST					464,500
1. Insurance, permits, taxes	4% operating				18,600
2. Rehabilitation costs					NA
3. Periodic site review (e)					NA
4. Contingency	25% operating				116,100
TOTAL ANNUAL OPERATING COST (+50%, -30%)					599,200

a. Operator is required to check system once per week (at 8 hours/trip).
b. Start-up sampling costs are not included.
c. 9 Borings with split spoon sampling.
d. Soil analysis includes a total of 25 samples.
e. Every 5 year; cost shown is allocation for 1 year.
NA - Not applicable.

TABLE A-7. BIOVENTING FOR ST-12 DEEP SOILS
Initial Capital Costs

Williams AFB
Project-409877.010
KT - S4FI - 03/29/95

COST COMPONENT	DESCRIPTION	COST ($)
DIRECT CAPITAL COSTS		
1. Site Preparation	3 acres	10,000
2. Extraction Wells	All wells are 4" diameter	
- A34 (Area SB-6, 7, 9A, 9B), and	16 wells at 180 ft deep, and 16 wells at	651,000
- A3 (Area SB-4, 5, 8, 10, 11)	215 ft deep, each has 35 ft screen	
- A2 (SB-3)	1 well at 215 ft deep, 35 ft screen	
3. Passive vent wells	11 wells at 215 ft deep, 4" diameter	236,000
4. Demobilization of operating wells	After completion of the operation (44 wells)	143,000
5. Nested piezometers	Extraction well nearby will be used	0
6. Piping system and foundation (surface sealing is not included)	2,000 linear feet (4",6 "and 10" diameter) (underground construction cost is included)	183,000
7. Bio Vacuum Skid-Mounted Systems	Including air/water separator & instrumentation	
One 600 scfm blower	18" Hg vacuum, 125 hp motor	93,000
8. Condensate transfer system (pump, tank, and piping)	Condensate from 1 air/water separator will be pumped to the existing system	14,000
9. One Thermal Oxidation System with catalytic module (no heat exchanger)	Skid mounted system, rated for 1,000 scfm 3 million (MM) btu/hour, 1,400° F	103,000
10. Nutrient system	Ammonia and phosphate system	NA
11. Electrical equipment	Including installation, wiring, and telemanager monitoring system	32,000
12. Shipping	8% of items 7 and item 9 (approx)	15,700
TOTAL DIRECT COSTS (TDC)		1,480,700
INDIRECT CAPITAL COSTS		
1. Engineering and related tech support	15 % TDC	222,100
2. SVE Pilot Test	Air permeability and pressure test (well installation is not included)	105,000
3. Bioassessment, bio treatability test	In situ pilot bio treatability test	175,000
4. License, Permit, and Legal Fees	2 % TDC	29,600
5. Start-up (sampling costs are included)	5 % TDC	74,000
6. Contingency	25 % TDC	370,200
TOTAL INSTALLED COST (+50%, -30%)		2,456,600

NA - Not applicable.

TABLE A-8. BIOVENTING FOR ST-12 DEEP SOILS
Annual Operation and Maintenance Costs

Williams AFB
Project-409877.010
KT - S4FI - 03/29/95

COST COMPONENT	UNIT COST ($)	UNIT	QTY	UNITS/ PERIOD	ANNUAL COST ($)
1. Operating labor (a)	50	hour (hr)	8	hours per week	20,800
2. Monitoring labor	50	hour (hr)	8	hours per month	4,800
3. Maintenance					10,000
4. Materials					NA
5. Utilities					
. Electric Power					
1 Vacuum skid (125 Hp), gas fan, and water pumps.	0.08	Kwhr	2,820	Kwhr/day	82,300
. Fuel for fume incineration.	5.00	million btu	16.8	million btu/day	30,700
6. Disposal					NA
7. Purchased services:					
a) Vapor samples analyses (b)	400	sample	6	samples/month	28,800
b) Water samples analyses	350	sample	1	samples/month	4,200
c) Soil Boring (b) (c)	90,000	sampling event	9	borings/2 years	45,000
d) Soil Monitoring (TCL and VOC) (d)	10,000	sampling event	1	sampling event/ 2 years	5,000
e) Soil Bio Monitoring (9 bores, 15 samples)	8,000	sampling event	1	sampling event/ 2 years	4,000
8. Data evaluation	100	hr	40	hr/ 3 months	16,000
TOTAL OPERATING COST					251,600
1. Insurance, permits, taxes	4% operating				10,100
2. Rehabilitation costs (e)					14,000
3. Periodic site review					NA
4. Contingency	25% operating				62,900
TOTAL ANNUAL OPERATING COST (+50%, -30%)					338,600

a. Operator is required to check system once per week (at 8 hours/trip).
b. Start-up sampling costs are not included.
c. Nine borings with split spoon sampling.
d. Soil analysis includes a total of 25 samples.
e. Replacement of mechanical components every 10 years.
NA - Not applicable.

TABLE A-9. SVE AND BIOVENTING FOR ST-12 DEEP SOILS
Initial Capital Costs

Williams AFB
Project-409877.010
KT - S5FI - 03/29/95

COST COMPONENT	DESCRIPTION	COST ($)
DIRECT CAPITAL COSTS		
1. Site Preparation	3 acres	10,000
2. Extraction Wells	All wells are 4" diameter	
- A34 (Area SB-6, 7, 9A, 9B), and	16 wells at 180 ft deep, and 16 wells at	651,000
- A3 (Area SB-4, 5, 8, 10, 11)	215 ft deep, each has 35 ft screen	
- A2 (SB-3)	1 well at 215 ft deep, 35 ft screen	
3. Passive vent wells	11 wells at 215 ft deep, 4" diameter	236,000
4. Demobilization of operating wells	After completion of the operation (44 wells)	143,000
5. Nested piezometers	Extraction well nearby will be used	0
6. Piping system and foundation (surface sealing is not included)	2,000 linear feet (4",6 "and 10" diameter) (underground construction cost is included)	183,000
7. Bio Vacuum Skid-Mounted Systems	Including air/water separator & instrumentation	
Two 1,000 scfm blower	18" Hg vacuum, 200 hp motor each	218,000
8. Condensate transfer system (pump, tank, and piping)	Condensate from 2 air/water separator will be pumped to the existing system	14,000
9. One Thermal Oxidation System with catalytic module (no heat exchanger)	Skid mounted system, rated for 3,000 scfm 10 million (MM) btu/hour, 1,400° F	191,000
10. Nutrient system	Ammonia and phosphate system	NA
11. Electrical equipment	Including installation, wiring, and telemanager monitoring system	52,000
12. Shipping	6% of items 7 and item 9 (approx)	24,500
TOTAL DIRECT COSTS (TDC)		1,722,500
INDIRECT CAPITAL COSTS		
1. Engineering and related tech support	15 % TDC	258,400
2. SVE Pilot Test	Air permeability and pressure test (well installation is not included)	105,000
3. Bioassessment, bio treatability test	In situ pilot bio treatability test	175,000
4. License, Permit, and Legal Fees	2 % TDC	34,500
5. Start-up (sampling costs are included)	5 % TDC	86,100
6. Contingency	25 % TDC	430,600
TOTAL INSTALLED COST (+50%, -30%)		2,812,100

NA - Not applicable.

TABLE A-10. SVE AND BIOVENTING FOR ST-12 DEEP SOILS

Annual Operation and Maintenance Costs
(First and Second Year)

Williams AFB
Project-409877.010
KT - S5FI - 03/29/95

COST COMPONENT	UNIT COST ($)	UNIT	QTY	UNITS/ PERIOD	ANNUAL COST ($)
1. Operating labor (a)	50	hour (hr)	8	hours/week	20,800
2. Monitoring labor	50	hr	8	hours/month	4,800
3. Maintenance					10,000
4. Materials					NA
5. Utilities					
. Electric Power 2 Vacuum skids (400 Hp), gas fan, and water pumps.	0.08	Kwhr	8,146	Kwhr/day	237,900
. Fuel for fume incineration.	5.00	MM BTU	50.4	million btu/day	92,000
6. Disposal					NA
7. Purchased services:					
a) Vapor samples analyses (b)	400	sample	6	samples/month	28,800
b) Water samples analyses	350	sample	1	samples/month	4,200
c) Soil Boring (b) (c)	90,000	sampling event	9	borings/2 years	45,000
d) Soil Monitoring (VOC) (d)	10,000	sampling event	1	sampling event/ 2 years	5,000
e) Soil Bio Monitoring (9 bores, 15 samples)	8,000	sampling event	1	sampling event/ 2 years	NA
8. Data evaluation	100	hr	40	hr/ 3 months	16,000
TOTAL OPERATING COST					464,500
1. Insurance, permits, taxes	4% operating				18,600
2. Rehabilitation costs (e)					NA
3. Periodic site review					NA
4. Contingency	25% operating				116,100
TOTAL ANNUAL OPERATING COST (+50%, -30%)					599,200

a. Operator is required to check system once per week (at 8 hours/trip).
b. Start-up sampling costs are not included.
c. Nine borings with split spoon sampling.
d. Soil analysis includes a total of 25 samples.
e. Replacement of mechanical components every 10 years.
NA - Not applicable.

TABLE A-11. SVE AND BIOVENTING FOR ST-12 DEEP SOILS
Annual Operation and Maintenance Costs
(Third Year and Later)

Williams AFB
Project-409877.010
KT - S5FI - 03/29/95

COST COMPONENT	UNIT COST ($)	UNIT	QTY	UNITS/ PERIOD	ANNUAL COST ($)
1. Operating labor (a)	50	hour (hr)	8	hr/week	20,800
2. Monitoring labor	50	hour (hr)	8	hours/month	4,800
3. Maintenance					10,000
4. Materials					NA
5. Utilities					
. Electric Power					
1 Vacuum skid (200 Hp) gas fan, and water pumps.	0.08	Kwhr	4,521	Kwhr/day	132,000
. Fuel for fume incineration.	5.00	million btu	16.8	million btu/day	30,700
6. Disposal					NA
7. Purchased services					
a) Vapor samples analyses (b)	400	sample	6	samples/month	28,800
b) Water samples analyses	350	sample	1	samples/month	4,200
c) Soil Boring(b)(c)	90,000	sampling event	9	borings/sampling event	45,000
d) Soil Monitoring (VOC) (d)	10,000	sampling event	1	sampling event/ 2 years	5,000
d) Soil Bio Monitoring (11 bores, 15 samples)	8,000	sampling event	1	sampling event/ 2 years	4,000
8. Data evaluation	100	hr	40	hr/ 3 months	16,000
TOTAL OPERATING COST					301,300
1. Insurance, permits, taxes	4% operating				12,100
2. Rehabilitation costs					NA
3. Periodic site review					NA
4. Contingency	25% operating				75,300
TOTAL ANNUAL OPERATING COST (+50%, -30%)					388,700

a. Operator is required to check system once per week (at 8 hours/trip).
b. Start-up sampling costs are not included.
c. Nine borings with split spoon sampling.
d. Soil analysis includes a total of 25 samples.
e. Replacement of mechanical components every 10 years.
NA - Not applicable.

APPENDIX B

LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Table B-1

Location-Specific Applicable or Relevant and Appropriate Requirements
Liquid Fuels Storage Area (ST-12)
Operable Unit 2, Williams Air Force Base

Location	Requirement(s)	Prerequisite(s)	Citation	Comments	A[a]	RAR[b]
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	Action to recover and preserve artifacts	Alteration of terrain that threatens significant scientific, prehistoric, historic, or archaeological data	National Archaeological and Historical Preservation Act (16 USC Section 469); 36 CFR Part 65			ST12-3 ST12-4 ST12-5

[a]Criteria is applicable for alternatives listed.
[b]Criteria is relevant and appropriate for alternatives listed:
Alternative ST12-1: No Action
Alternative ST12-2: Natural Attenuation
Alternative ST12-3: Soil Vapor Extraction
Alternative ST12-4: Bioventing
Alternative ST12-5: Soil Vapor Extraction, Bioventing, and Natural Attenuation

Table B-2

Action-Specific Applicable or Relevant and Appropriate Requirements
Liquid Fuels Storage Area (ST-12)
Operable Unit 2, Williams Air Force Base

Action	Requirement(s)	Prerequisite(s)	Citation	Comments	A[a]	RAR[b]
Air Emissions Control During Remediation	Control of air emissions of volatile organics, particulates, and gaseous contaminants.	Emission of VOCs, particulates, and gaseous air contaminants	Maricopa County Air Quality Standards (Rules 200, 210, 220, 320) as dictated by the Clean Air Act		ST12-3 ST12-4 ST12-5	
Surface Water Control	Prevent run-on and control and collect runoff from a 24-hour 25-year storm (land treatment facility).	RCRA hazardous waste treated, stored, or disposed after the effective date of the requirements.	40 CFR 264.273 (c) (d)		ST12-2 ST12-3 ST12-4 ST12-5	
Container Storage (On Site)	Containers of hazardous waste must be: • Maintained in good condition • Compatible with hazardous waste to be stored • Closed during storage (except to add or remove waste). Inspect container storage areas weekly for deterioration. Place containers which contain free liquid on sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids or the volume of the largest container, whichever is greater.	RCRA hazardous waste (listed or characteristic) held for a temporary period before treatment, disposal, or storage elsewhere (40 CFR 264.10) in a container (i.e., any portable device in which a material is stored, transported, disposed of, or handled).	 40 CFR 264.171 40 CFR 264.172 40 CFR 264.173 40 CFR 264.174 40 CFR 264.175	These requirements are applicable for any contaminated soil, groundwater, or treatment system waste that might be containerized and stored on site prior to treatment or final disposal. Groundwater or soil containing a listed waste must be managed as if it were a hazardous waste so long as it contains a constituent of the listed waste.	ST12-2 ST12-3 ST12-4 ST12-5	

Table B-2

(Page 2 of 2)

Action	Requirement(s)	Prerequisite(s)	Citation	Comments	A[a]	RAR[b]
Container Storage (On Site) (Continued)	Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system.		40 CFR 264.175		ST12-2 ST12-3 ST12-4 ST12-5	
	Keep containers of ignitable or reactive waste at least 50 feet from the facility's property line.		40 CFR 264.176			
	Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier.		40 CFR 264.177			
	At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.		40 CFR 264.178			
	Storage of banned wastes must be in accordance with 40 CFR 268. When such storage occurs beyond 1 year, the owner/operator bears the burden of proving that such storage is solely for the purpose of accumulating sufficient quantities to allow for proper recovery, treatment, and disposal.		40 CFR 268.50			
Pretreatment for Discharge to POTW	Establish agreement with POTW with regards to pretreatment effluent discharge limits for treated water.	Discharge of treated water to POTW	40 CFR 403	Need to establish with POTW prior to discharge.	ST12-3 ST12-4 ST12-5	

[a] Criteria is applicable for alternatives listed.
[b] Criteria is relevant and appropriate for alternatives listed.
Alternative ST12-1: No Action
Alternative ST12-2: Natural Attenuation
Alternative ST12-3: Soil Vapor Extraction
Alternative ST12-4: Bioventing
Alternative ST12-5: Soil Vapor Extraction, Bioventing, and Natural Attenuation